BEEKEEPING IN THE TROPICS

NOTE

THIS volume is one of a series of books on tropical agriculture which are being published with active encouragement of the Colonial Advisory Council of Agriculture, Animal Health and Forestry. Since the death of the late Sir Harold Tempany, the editor has been Mr. D. Rhind, O.B.E., F.L.S., Secretary for Colonial Agricultural Research and formerly Economic Botanist, Burma, and Director of Agriculture, Ceylon.

ALREADY PUBLISHED

Rice, 3rd edition, by D. H. Grist; *Cocoa*, 2nd edition, by D. H. Urquhart; *Tea*, by T. Eden; *Introduction to Animal Husbandry in the Tropics*, by G. Williamson and W. J. A. Payne; *Bananas*, by N. W. Simmonds.

OTHER VOLUMES IN PREPARATION

Rubber, by E. D. C. Baptiste; *Oil Seeds*, by A. H. Bunting; *Coconuts*, by R. Child; *Sorghum*, by H. Doggett; *Tropical Soils*, by H. Greene; *Termites*, by W. V. Harris; *Oil Palms*, by C. W. S. Hartley; *Tropical Freshwater Fish*, by C. F. Hickling; *Insect Pests of Tropical Crops*, by W. F. Jepson; *Cotton*, by A. N. Prentice; *Handbook of Tropical Agricultural Botany*, by J. W. Purseglove and P. Richards; *Spices*, by G. E. Tidbury; *Introduction to Tropical Agriculture*, by C. C. Webster.

BEEKEEPING IN THE TROPICS

FRANCIS G. SMITH
B.Sc. (FOR.), D.Sc., N.D.B.

Head of the Beekeeping Division
Forest Department Tanganyika
Founder Member, Bee Research Association

1724

LONGMANS

LONGMANS, GREEN AND CO LTD
6 & 7 CLIFFORD STREET, LONDON W1
THIBAULT HOUSE, THIBADLT SQUARE, CAPE TOWN
605–611 LONSDALE STREET, MELBOURNE C1
443 LOCKHART ROAD, HONG KONG
ACCRA, AUCKLAND, IBADAN
KINGSTON (JAMAICA), KDALA LUMPUR
LAHORE, NAIROBI, SALISBDRY (RHODESIA)

LONGMANS, GREEN AND CO INC
119 WEST 40TH STREET, NEW TORK 18

LONGMANS, GREEN AND CO
20 CRANFIELD ROAD, TORONTO 16

ORIENT LONGMANS PRIVATE LTD
CALCUTTA, BOMBAY, MADRAS
DELHI, HYDERABAD, DACCA

First published 1960

and correspondents in Africa, India, South Asia and tropical America who have supplied me with information on their local conditions. In particular, the following have been most helpful: Mr. Townley and Mr. Nightingale of Kenya, Mr. Baldwin and Col. Conner of Tanganyika, Miss Gamwell of Northern Rhodesia, Mr. Hornby of Southern Rhodesia, Señor Virgilio de Portugal Araujo of Angola, Pandit R. N. Muttoo of Nainital District, Himalayas, Dr. Sardar Singh of the Punjab, Dr. Warrick Kerr and Mr. P. Noguiera-Neto of Brazil.

I must also thank the Controller, H. M. Stationery Office, for permission to use the three photographs from the Ministry of Agriculture and Fisheries Advisory Leaflet No. 362, "The Examination of Bees for Acarine Disease", and the Rothamsted Experimental Station for the four photographs from Advisory Leaflet No. 306, "Foul Brood".

In addition, I should like to thank Mr. Robert Sangster, Chief Conservator of Forests, Tanganyika, for his encouragement and the helpful suggestions he made when he checked the draft of this book.

Finally, a special word of thanks to my wife who helped with the typing and corrected my spelling and grammatical construction.

F. G. Smith

Tabora,
October 1958

CONTENTS

APPENDICES

PLATES

IN COLOUR

IN BLACK AND WHITE

Between pages 104–105

Facing page 112

Facing page 113

Between pages 128–129

The line drawings, colour photographs and black and white photographs are by the author, with the exception of the three photographs, Plates 12, 13 and 14, which are reproduced from *The Examination of Bees for Acarine Disease, Advisory Leaflet No. 362* by permission of the Controller, H.M. Stationery Office, and the four photographs, Plates 15, 16, 18 and 19, which are reproduced by permission of Rothamsted Experimental Station.

I

BASIC PRINCIPLES

Chapter I

BEE FARMING

Extent of the Industry—Development of Commercial Beekeeping—Hobbyist Beekeeping—Developments in the Tropics—The Beginnings of a Bee Farm.

THE average person knows little about another man's job, unless from its very nature it is in the public eye. Many forms of agriculture are familiar because they are so obvious, vast areas of sisal, cotton, coffee, tea, tobacco or rice. There is so much of it that you cannot help noticing it. Forestry is a little less obvious, except where plantations are established for all the world to see, sawmills emit their shrill whine or timber lorries block the roads. But unless you are very fond of honey, and prefer the local brand, you may be quite unaware that there is a commercial beekeeper making a very good living not far away. In all probability the only public sign of his activity will be a small notice, HONEY. The sources of supply of his product are kept well out of sight, for two good reasons: they are very valuable, and they sting.

So unless you have already been interested in beekeeping and have read some of the leading bee journals of the world, or a major textbook on beekeeping, you will not be aware that the bee farmers of the United States of America produce 242,000,000 pounds of honey worth $24,200,000 each year and 4,476,000 pounds of beeswax worth over $4,000,000; or that the U.S.S.R. produces an equal amount of honey mainly from collective farm apiaries, but nobody knows what they do with their beeswax; that Australia produces 40,500,000 pounds of honey, exports 13,000,000 pounds of it worth £900,000, and produces 500,000 pounds of beeswax as well, mainly the produce of bee farmers who move their hives, sometimes hundreds of miles each year following the flowering of the forest; that Tanganyika produces about £750,000 worth of honey and £250,000 worth of beeswax, chiefly from beekeepers who each operate 200 to 1,000 simple hives in the deciduous woodland, and that these bee products are worth more than the timber produced from the same areas, and nearly as much as the timber produced from the whole territory; or that in 1942, two Germans in Mexico bought seven hives of bees from which

in the first season they obtained an average of 37 pounds of honey per hive, and that today they own 20,000 honey-producing colonies averaging 200 pounds of honey per hive each year, a total of 4,000,000 pounds, as well as producing 30,000 queens each year, beeswax and royal jelly, and they turn out 200 fully equipped frame hives each day from their workshops.

What sort of people are these bee farmers, you may ask. Well, they are mainly quiet unassuming people who go about their business without worrying others, they are seldom in the courts and their arguments they keep for fellow beekeepers; they may be pillars of the kirk, play cricket with you on a Saturday afternoon, or climb Everest. They probably will not appear to have two cents to rub together, but they may have several thousand pounds in the bank, under the floor or in the bottom of a hive of bees. On the other hand they may have a substantial overdraft.

Let us step back a pace and glance briefly at what has happened in beekeeping circles during the past one hundred years or so. Up to one hundred years ago, beekeeping was practised in those parts of the world where people had the aptitude for it much as it is practised today in many tropical countries. Hives were simple containers made of straw, hollowed-out logs, mud, basket-work or plain wooden boxes. No management was done on the hive, and at the end of the flowering season the bees were either driven out or killed, and the combs of honey and beeswax cut out of the hives.

About that time, a number of people in Europe and America were trying to discover a way of making a hive which was an improvement on the simple container. No progress was made until, in the year 1851, the Rev. L. L. Langstroth appreciated the significance of his observation that bees leave a space of approximately five-sixteenths of an inch between their combs. The hive he designed with hanging movable frames for containing the combs, surrounded by the five-sixteenths of an inch bee space, made hive management possible. His book, *Langstroth on the Hive and the Honeybee, a Bee Keeper's Manual*—first published in 1853, and later revised by the Dadants in many editions and translated into French, Russian, Italian, Spanish and Polish—blazed the trail of modern commercial beekeeping.

As the techniques of frame hive management were mastered, the use of the Langstroth and Dadant hives spread and there emerged the commercial beekeepers of America, Canada, Australia, New Zealand and Europe.

But in parts of Western Europe, particularly in Germany and England, other influences were at work. Langstroth's book had not been translated into German, and in England there was a resistance

to American ideas. The fathers of beekeeping in England, who demonstrated in frock-coat and top hat, considered that it was not possible to make a living from bees, but recommended it as a profitable bobby, a source of entertainment and possibly pocket money for the cottager. They were quite correct in saying that profitable commercial beekeeping was not possible, using the type of equipment and technique they advocated. Their teaching held British beekeeping in thraldom for fifty years, until a few hardy types, having already lost quite a lot of money experimenting with the fancy hives of the orthodox school, turned to those across the Atlantic who were making a living from beekeeping. And so, casting off tbe traditions of the exponents of hobbyist beekeeping, they took up the approach and technique of the commercial beekeepers of America and Australia, and are today tbe commercial beekeepers of Britain.

In the cooler parts of South America modern commercial bee farms gradually came into being and more recently tbere has been considerable development in the tropical parts and in Central America. In Africa, a few bee farmers using modern methods have become established, mainly in the south, but the viciousness of the otherwise very prolific and productive African bees has made bee management so difficult that the old primitive methods continue to be the major source of production.

Into India came the English hobbyist beekeeping approach with minute hives and no idea of commercial technique. This has had the same effect as in England of hindering the development of the industry. However, a few beekeepers have broken away from the orthodox approach and have established modern productive bee farms. And from Malaya too comes similar news.

During the past ten years a great wealth of knowledge about tropical beekeeping has been obtained in tropical America, Africa and India and even the intractable African bee has been mastered. The way now seems clear for the development of beekeeping industries in the tropics comparable with those in temperate climates. It is hoped that this book will do something to help this movement along, by giving those who are seeking to make progress a sound foundation on which to build.

No successful bee farm was ever developed overnight. All have had small beginnings, the beekeeper expanding his enterprise as he has become more proficient in his bee management. The important thing is to start on the right lines, to start with suitable equipment and the business approach. The prospective bee farmer must be prepared to work hard and learn, and he must have a natural aptitude for the work. In addition to obtaining knowledge from reading,

attending courses or practical experience on an established bee farm, the bee farmer requires a deep sympathy with the workings of Nature, so that he can work with Nature. Bees are wild creatures, they are never tame, and the beekeeper learns much from them.

It requires no company or corporation to start a bee farm. It is an individual and personal effort. The apiaries and buildings of a bee farm occupy very little valuable ground, and usually they are sited on waste ground that is of no value to agriculture, or in orchards or woodlands and forests. Beekeeping causes no soil erosion and its value to agriculture in terms of pollination services is beyond calculation. But no man, however determined, can become a successful bee farmer without knowledge, aptitude, suitable equipment, productive strains of bees and a region with an abundance of nectar-producing plants within reach of his bees.

Chapter II

THE HONEYBEE

Bees, Plants and Man—Social Bees—The Honeybees—European Races of 'Apis mellifera'—African Races of 'Apis mellifera'—Asian Races of 'Apis mellifera indica'—The Honeybees of the Tropics—The Honeybee Colony—The Comb—Nesting Places.

BEES, PLANTS AND MAN

BEES are dependent for their very existence upon the nectar and pollen which they obtain from flowering plants. In their turn, many plants are dependent upon bees for the transfer of pollen from the anthers to the stigma in order that seed may be produced. Frequently, more vigorous offspring are produced if the pollen from another plant is transferred to an individual of the same species. The dispersal of pollen from some plants is carried out by the wind. This is extremely wasteful and vast quantities of pollen have to be produced to achieve adequate cross-pollination, though the pollen may be carried very great distances by the wind. Insect-pollinated plants produce less pollen and this is carried by bees for comparatively small distances. The plants which are dependent upon bees for pollination are equipped with floral nectaries which attract the bees as well as other insects. For the bees, the nectar is the source of carbohydrate food while the pollen is rich in protein.

In agriculture, man needs the services of bees for the pollination of seed and fruit crops. This dependence upon bees has been more deeply appreciated during the present century and many farmers in highly developed countries hire hives of bees during the flowering of fruit and seed crops. The honey produced by bees was the only source of sweetening available to man in many parts of the world until the cultivation of sugar-cane developed. Its importance in this respect continues, particularly in tropical Africa, Asia and among some of the peoples of tropical America. Beeswax, which has long been required for making church candles, has become increasingly important in organized society and has over two hundred different uses today, of which the most important are in the manufacture of cosmetics, polishes and pharmaceutical preparations. A product of the

honeybee for which a demand has only recently developed is royal jelly, a food rich in protein which is produced by the bees for feeding to the queen and the young larvae. Experiments are taking place to determine the value of royal jelly in cosmetics and medicine.

SOCIAL BEES

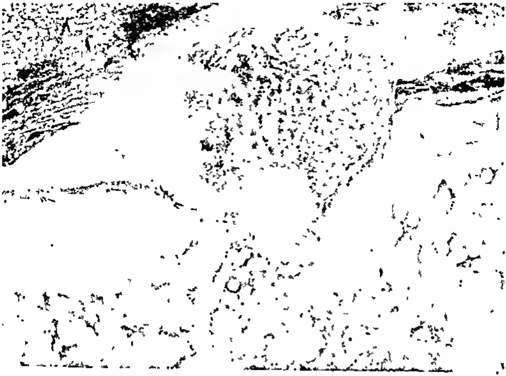
Three families of social bees produce honey, the Bombidae, Meliponidae and the Apidae. The Bombidae are found mainly in temperate climates. Their nests are very small, often in the ground. The brood is raised in waxen pots and the honey is stored in other wax pots for the queen to feed on during bad weather. The Bombidae are of no commercial importance except as pollinators of certain plants, the nectaries of which are out of reach of the tongues of smaller bees.

The Meliponidae, or stingless bees, occur throughout the tropical regions of the world, with the greatest number of species in tropical America. Their nesting places may be holes in the ground, in hollow trees or small cavities in walls, and in some cases, on the underside of branches. The stingless bees, some of them very minute, do not store honey in combs but put it in waxen pots. Some species arrange their brood in irregular clusters. The rest of the Meliponidae build horizontal combs containing only one layer of brood in each comb, with the sole exception of one African species (*Trigona*) *Dactylurina staudingeri*, which makes vertical double-sided brood combs (1). The honey of the various stingless bees is pleasant to eat but the quantities produced are small. Nevertheless, in Mexico and South America (2), the most productive species, *Melipona beechii*, is kept in horizontal log hives and in Africa *Trigona togoensis* is sometimes found nesting in log hives put up for the ordinary honeybee. In Brazil (3), special hives of modern design have been developed for use with different species of Meliponidae and in Angola (4) other types have been designed for use with some of the African *Trigona*.

THE HONEYBEES

The family Apidae, to which the honeybee belongs, is indigenous only to Europe, Africa and Asia. Although the Meliponidae are also indigenous in the tropics of Australia and America, none of the Apidae had arrived until *Apis mellifera* was taken to those countries by emigrants from Europe. In the Apidae, both honey and pollen are stored in vertical double-sided combs, and the brood is raised in the same or similar combs.

Apis mellifera Linnaeus is native only to Europe, but it has been



1. Nest of stingless bees, *Doctylurina staudingeri*, on the underside of a branch of a tree

2. Nest of stingless bees, *Trigona denoiti*, in the middle of a termite nest. The *Trigona* nest has been opened to show the spiral formation of the horizontal brood combs

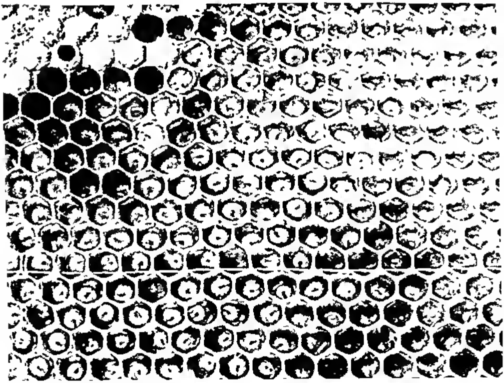
3. Nest of honeybees, *Apis mellifera adansoni*, on the underside of a branch of a tree near Morogoro, Tanganyika

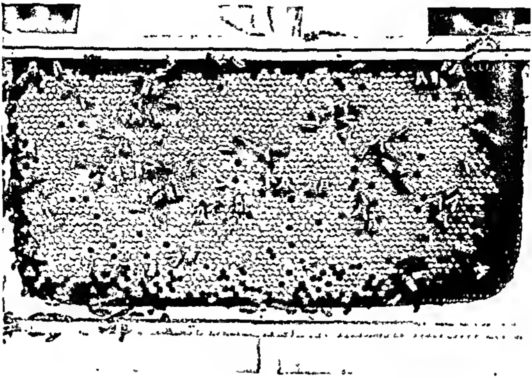
4. Close-up of the nest in Plate 3. The local people say that this nest has been in that place for at least ten years

5. Drone (*above*) and queen (*below*) (×1·5)

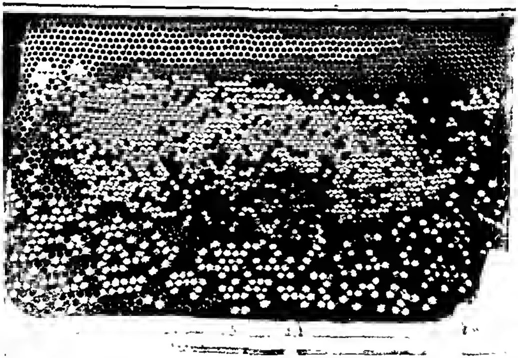
6. Queen (*above*) and worker (*below*) (×1·5)

7. Worker brood in all stages





8. A good comb of sealed worker brood



9. Worker brood and drone brood. The drone brood is in the lower part of the comb

introduced to North and South America and Australasia where it has proved highly successful (5). *Apis mellifera adansoni* Latreille is a subspecies of the European honeybee and is confined to Africa (6). In India, Pakistan, Ceylon and other parts of South Asia there are three indigenous species of *Apis*. One of these, *Apis mellifera indica* Fabricius, is so similar to the European *A. mellifera*, differing mainly in size, that there appears to be a case for regarding it as being of the same species. As more is learnt about the African variety (7), which shows great affinity with *indica* in behaviour, this view is strengthened. The other two Asian bees are *Apis dorsata* and *Apis florea* (8) (9).

The Little Honeybee, *A. florea*, is the smallest of the genus *Apis*. One comb only is built, up to about four inches across, suspended from the branches of a bush or small tree. The comb is double-sided, that is, it has cells on both sides. The cells are very small, only about one-tenth of an inch across and only one or two ounces of honey are produced. Nevertheless, the honey is collected for medicinal purposes.

The Giant Honeybee, *A. dorsata*, also builds only one comb, but this is very large, up to six feet long and three feet deep. The combs are suspended from rocks or branches of trees and may hold up to forty pounds of honey. The upper part of the comb, which contains the honey, may be four inches thick, but the lower part, where the brood is raised, is only one and a half inches thick. The cells are about one-fifth of an inch across, approximately the same size as the European *A. mellifera*, but twice as deep. The drones are reared in cells the same size as those used for the workers. No success has been achieved in attempts to keep this bee in hives. Nevertheless, considerable quantities of honey and wax are collected from the wild colonies, and there is international trade in the wax, known as Ghedda wax.

European Races of 'Apis mellifera'

Apis mellifera Linnaeus is regarded as having five different races, each with its own characteristics (8). It should be borne in mind that though there are these differences between various races of bees, the differences between strains of any one race are often wider.

The Italian, *ligustica*, is the bee most widely used, especially by commercial beekeepers. There are yellow bands on each of the first three segments of the abdomen and the hairs are reddish. The queen is variable in colour but usually a yellow brown. Very yellow varieties are sometimes encountered. The drones are light coloured. These bees are sometimes bred for colour and are known as golden, but bees so bred are not popular with bee farmers. The Italian is a good

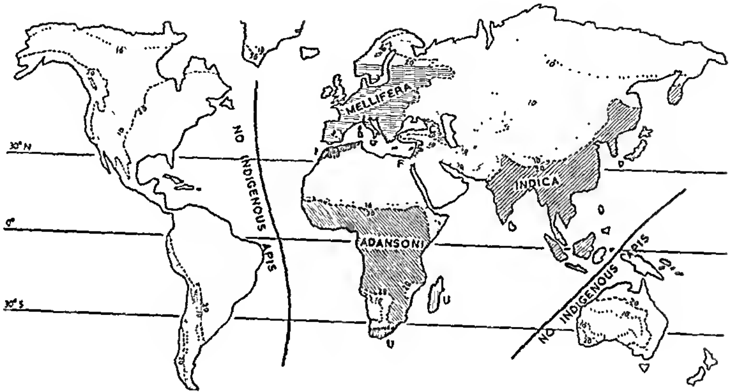


Fig. 1

MEAN ANNUAL RAINFALL MAP SHOWING APPROXIMATE DISTRIBUTION OF INDIGENOUS EUROPEAN, AFRICAN AND ASIAN HONEYBEES

L—*ligustica*; C—*caucasia*; S—*syrica*; I—*intermissa*; F—*fasciata*; U—*unicolor*.

Over 20 in., honeybees able to spread freely; between 10 and 20 in., movement of honeybees less widespread in the tropics; under 10 in., honeybees confined to oases and rivers in the tropics.

forager and builds up rapidly. It does not swarm much provided it is given adequate room in the hive. Its popularity among beekeepers in Europe, America and Australasia who depend upon bees to earn them a living is as good an advertisement as any for this race.

The Carniolan, *carnica*, is popular with some commercial bee-keepers especially in the United States of America. It is a dark bee, with rings of light-coloured hairs on the abdomen. It is a good honey producer but inclined to excessive swarming.

The Caucasians, *caucasia*, are dark bees having an olive tone in the appearance of their bodies. They are popular with some bee-keepers and are considered very gentle. They use a lot of propolis in the hive as well as at the entrance. This propolis is a resinous material collected from plants and used for building defensive structures. A variety of Caucasians showing yellow or orange markings on the abdomen is found at lower altitudes.

The dark brownish-black bees of North Germany, Scandinavia and formerly of Britain, *lehzeni*, are very hardy but have a shorter tongue than the other races.

The French and Dutch bees, *mellifera*, are another dark race. The French varieties have a good reputation as honey producers but are difficult to control. The Dutch variety has a strong tendency to swarm and a reputation for being unreliable as a honey producer.

African Races of 'Apis mellifera'

The main African race of honeybee is *Apis mellifera adansoni* (6) (10) (11), and is usually banded with yellow. The workers are slightly smaller than those of the European races. The cells of the worker comb are also smaller and the spacing between combs in wild nests is only 1¼ in. as opposed to the European 1⅜ in.

The *adansoni* bee is the common race of honeybee in tropical Africa extending from the Sahara in the north to the Cape Province in the south and from the east to west coast. Although most, and often all, the workers in a colony may show the characteristic *adansoni* coloration, yellow bands on the first three abdominal segments, yellow scutellum and yellow hairs, there are also darker individuals (6) (7) (10) (11). At the higher altitudes, where the climate is cooler, and occasionally on the coast, darker varieties occur. The darkest variety having no yellow on the abdomen, but usually with the yellow scutellum and yellow hairs, was called *friesei* by Buttel-Reepen (10) (11). The drones of otherwise normal *adansoni* colonies may be yellow-banded or quite dark. There is no evidence of any difference between the varieties other than the tendency for the bees to be darker in the mountainous areas (7).

Variation in the size of workers is evident, and this appears to be due to the availability of food for the worker larvae and the size of the worker cells in the comb. Workers reared in comb built out from European *A. mellifera* foundation are distinctly larger than those reared in wild comb. Naturally built *adansoni* comb has worker cells ranging in size from 4·77 mm. to 4·94 mm. across (5¼ to 5½ cells to each inch) but the normal size is 4·80 mm. across.

The vast numbers of wild colonies of this bee which are to be found in the woodlands and forests, as well as in the primitive hives of the beekeepers, indicate its success in withstanding the vagaries of the climate and attacks by numerous enemies. The *adansoni* bee is a good honey producer but is sometimes rather difficult to manage owing to the readiness with which it defends its hive. There is considerable difference between strains and an improvement in stock can be obtained by selective breeding. Kerr (12), reporting on *adansoni* bees imported into Brazil, found the best strains to be the most prolific, productive and vigorous bees he had ever encountered.

The Egyptian bee, *fasciata* Latreille, has reddish-yellow bands on the first three abdominal segments and silvery hairs (10). Although confined to Egypt, it appears to be closely allied to the Cyprian and Syrian varieties as well as to the main African honeybee, *adansoni*.

The Tellian, Punic or Tunisian bee, *intermissa* Buttel-Reepen (1906), occurs in Malta and North Africa (10). It is all black but possesses bands of grey hairs on the abdomen, and is of the European type (13). A variety of similar appearance occurs also in Cape Province in South Africa. It has a reputation for being very vicious and it has the peculiarity of being able to produce queens from the eggs of laying workers (14).

The race *unicolor* Latreille (1804) is confined to the islands of Madagascar, Réunion and Mauritius (10). It is an all-black bee without fringes of grey hair.

The Races of 'Apis mellifera indica'

Apis mellifera indica Fabricius (1789), ranging from the Himalayas to the south of India and Ceylon, through South-east Asia and the Indonesian islands and Philippines and up into China and Japan, has several races adapted to local conditions. In India two distinct varieties are recognized, the Hill variety, called *gandhiana* by Noguera-Neto, and the Plains variety, *indica* (9). Varieties have also been classified on the basis of colour, *picea* being dark, *indica* light and *peroni* an intermediate form. In China and Japan it appears in a more hairy form called *sinensis* or *japonica*.

The Hill variety ranges in colour from dark grey or black at the

higher altitudes, through dark brown to a distinct yellow tinge at the lowest altitudes. Variation in size occurs with altitude, tbe largest heing found at the highest zones. The size of worker cells is also variahle, ranging from 4·38 mm. across (5¾ to one inch) in tbe lowest areas to 4·84 mm. (5¼ to one inch) in the upper parts of its range (9). This latter is approximately the average size of *adansoni* worker cells in Africa.

The Plains variety normally has yellow hands on the first two to four ahdominal segments hut in the foothills mixtures with darker varieties occur. In North India the worker cells are 4·23 mm. across (6 to one inch) and may he even smaller in South India (9) (15).

The amount of honey produced each year hy *indica* races is small hy *mellifera* and *adansoni* standards. In North India the average crop is estimated to he ahout sixteen pounds while in the south it is only four or five pounds (9).

The Honeybees of the Tropics

In tropical America, the West Indies and the Pacific islands nearest America, the Italian race of *Apis mellifera* has hecome well estahlished in commercial heekeeping, which has long heen under the influence of American technique. As *Apis* was not indigenous in those parts, its natural predators could not have developed, so heekeepers there had a virgin field in which to develop their industry, hampered only hy the diseases hrought in with their hees.

Tropical Africa is fortunate in having the indigenous *adansoni* race in halance with its environment and reasonahly productive. The average annual crop from established colonies in simple hives is upwards of thirty pounds of honey and two pounds of beeswax. Attempts to introduce the European bee into tropical Africa have not yet been successful.

Tbe most productive bee of tropical Asia is *Apis dorsata* hut this species does not lend itself to beekeeping. It is the major source of Ghedda wax, and there seems little prospect of this being otber than the product of honey hunting or organized wax collection in the forests.

On the other hand, tbe *indica* hee is easily managed in frame hives. In the north of India some success is being obtained with the hill variety and selective breeding might result in better production. In the south of India and Ceylon production is so small that although many thousands of minute frame hives are in use, there appears little prospect of the development of large-scale commercial beekeeping with the use of the local bees. A number of attempts have been made to import *Apis mellifera* and to acclimatize it in India hut

no case of any success in this is on record. In view of the importance of the *adansoni* bee in tropical Africa, this race would appear to be the one which might have the greatest chance of success in areas having similar climatic conditions in the tropics of Asia.

In Singapore, Italian bees are being used successfully by a commercial beekeeper (16).

THE HONEYBEE COLONY

A bee colony is a complete biological unit within itself. The different components are as useless by themselves as a leg that is severed from a body. It is essential to regard the colony as an entire balanced unit and to treat it as such when management is considered. A normal colony is composed of up to some eighty thousand worker bees—rather less in the case of *indica* which has 20,000–24,000 (17)—several hundred drones and one queen. The bees dwell on wax combs, the cells of which contain eggs, larvae and pupae, pollen, honey and sometimes water. The whole nest is located in a suitable place, usually a cavity which affords protection against the elements and enemies.

The queen is the only fully developed female in the hive. She is the only bee that is able to be mated and lay normal eggs. She is, in fact, an egg-laying machine. The bees feed her with a special food high in protein and the rate of egg laying is governed by the amount of food consumed. She is able to walk about on the combs to select the cells in which to lay eggs. But after she has been mated she does not leave the hive again except with a swarm. The queen is slightly larger than a worker, having a larger thorax and longer legs. When only a virgin she is difficult to spot as her abdomen is much the same size as that of a worker, but when in full lay the abdomen is elongated and swollen and easy to see.

The drones are the male bees. Their sole function in life is to fertilize any young virgins which might require their services. They do not go out to work and do nothing useful in the hive other than, perhaps, assist slightly in keeping the hive warm with their presence. They seem to be even too lazy to feed themselves and prefer to beg food from busy workers. In a hive where there is an eligible virgin numerous drones will be found. They are accepted by any hive that has a virgin and they will come from colonies a considerable distance away. Mating takes place on the wing. The successful drone dies in the act of mating and the queen and drone fall to the ground together. The queen returns to the hive and about two days later starts laying eggs. At the end of the season, when there is no further use

for the drones, they are thrown out of the hive to die. Drones are larger than workers and heavier in build than queens. Their bodies are not pointed at the rear but are blunt and stingless.

The workers are under-developed female bees. As their name implies they do all the work in and out of the hive. The workers clean out the cells, feed the larvae, build the combs, clean and guard the hive, keep the hive cool by fanning, ripen the honey and collect pollen, nectar and water. Workers of *mellifera* may live as long as six months during the winter, but at the height of the honeyflow season they wear out and die after about six weeks. Workers of *indica* have a length of life of between three and six weeks during the honeyflow.

The Comb

The comb provides the accommodation for the raising of young bees and the storage of food. The combs are built of beeswax which is secreted by eight glands, four on each side of the underside of the abdomen of worker bees. The bees fill up with honey and cluster quietly for some hours hanging together like a bead curtain. The wax is secreted as a liquid by the glands and solidifies in the form of minute white scales in pockets between the overlapping parts of the abdominal segments. The scales are transferred to the jaws by the legs, and the wax is kneaded into the form of the comb. First, the wax is secured to the top of the cavity in which the bees are nesting. A central midrib is constructed and the cells, hexagonal in shape, are built out on both sides. The midribs of adjacent combs are about $1\frac{3}{8}$ in. apart in the case of European races, $1\frac{1}{4}$ in. apart in the case of the African *adansoni* and the largest of the hill varieties of *indica* and a little less in the plains varieties. As the combs increase in size they are attached to the sides of the cavity as well as to the top. Seldom do bees attach the combs to the extreme bottom of the hive.

The cells can be of three different sizes. The worker cells, in which the worker bees are raised, are the smallest, approximately one-fifth of an inch across in the case of *mellifera*, *adansoni* and the hill variety of *indica*, and about one-sixth of an inch in the plains variety. The drone cells, in which the male bees are raised, are about one-quarter of an inch in diameter in *mellifera* and *adansoni*. Both types of cells are used for storing honey and pollen, but normally there are many more worker cells than drone cells. The third type of cell is the queen cell. Queen cells are made only when it is necessary for the colony to produce a new queen, though the bees do sometimes make 'play cups,' which are the beginnings of queen cells, at other times. Queens

are raised when the colony has the urge to reproduce itself by swarming, or when the queen grows old and has to be replaced, or when an accident happens to the queen and a new one has to be raised in a hurry. Queen cells are built vertically, open end downwards. Swarm cells are usually found round the edges and bottoms of the combs. Supersedure cells are few in number and usually stand out on the face of the comb. Emergency cells, however, are built out from the midrib of the comb, as, in an emergency, eggs which have already been laid in worker cells are utilized.

There is an orderly arrangement in the colony. The brood area is in the form of a sphere in the lower part of the hive. On top and on each side of the brood is a band of stored pollen about two inches wide. Above and beyond the pollen band the honey is stored. A comb in the middle of the hive is a vertical section through the brood nest. If the bees are unhampered by the shape of the hive, the brood will be a circular patch near the bottom of the comb and the band of pollen will be seen clearly running round outside the patch of brood, with the honey above. The combs on each side of the brood nest will contain only small patches of brood and outside them will be combs containing a large quantity of pollen in the part adjacent to the brood nest. Any combs beyond the pollen combs will be stored with honey.

Nesting Places

Honeybees will occupy any convenient cavity which is (*a*) either weatherproof or can easily be made so by the bees, (*b*) gives protection from the many enemies of the colony, (*c*) does not become too hot in the sun, and (*d*) provides adequate ventilation. The most common nesting place is a hollow tree. Other nesting places are holes under rocks, caves, hollow termite nests, lofts, cavities in walls, cupboards, boxes, hollow electricity poles and chimneys. In some areas very favourable to the bees, colonies will establish themselves in more exposed positions, under large branches, in the crowns of palm trees and under the eaves of houses, so long as such places are protected from wind and heavy rain. If the selected place has cracks through which bees cannot pass, the bees seal up such cracks and holes with propolis, a resinous mixture with which they varnish the inside of the hive. If the entrance is larger than the bees can guard safely, they block it up with propolis leaving only a number of small holes which they can both guard and use to regulate the circulation of air in the hive. In such places as chimneys and hollow steel poles, the bees may build a partition across the cavity, both above and below the nest.

REFERENCES

1. SMITH, F. G. (1954). 'Notes on the biology and waxes of four species of African *Trigona* bees.' *Proc. R. ent. Soc. London Ser. A* 29(4/6): 62–70.
2. SCHWARZ, H. F. (1948). *Stingless bees (Meliponidae) of the Western Hemisphere*. Bull. Amer. Mus. Nat. Hist. 90.
3. NOQUEIRO-NETO, P. (1953). *A criação de abelhos indigenas sem ferrão*. Editora Chacaras e Quintais; Sao Paulo.
4. ARAUJO, V. de P. (1955). *Colmeias para 'obelhos sem ferrõo' Meliponini*. Instituo de Angola, Bull. No. 7.
5. SMITH, F. G. (1953). 'Beekeeping in the Tropics.' *Bee World* 34(12): 233–45.
6. SKAIFE, S. H. (1930). 'The South African Honey-bee.' *S. Afr. Bee J.* 5(2): 12–16.
7. SMITH, F. G. (1958). 'Beekeeping Observations in Tanganyika, 1949–57.' *Bee World* 39(2): 29–36.
8. BUTLER, C. G. (1954). *The world of the honeybee* (London: Collins).
9. MUTTOO, R. N. (1956). 'Facts about Beekeeping in India.' *Bee World* 37(7): 125–33; (8): 154–7.
10. ROTTER, E. (1931). 'African Races of Honey Bees.' *Bee World* 12(6): 67–8.
11. COCKERALL, T. D. A. (1936). 'African Honey Bees.' *Noture* 8(7): 249.
12. KERR, W. E. (1957). 'Introduction of African bees to Brazil.' *Brosil opic.* 3(5): 211–13.
13. ADAM, BROTHER (1954). 'In search of the best strains of bee; second journey.' *Bee World* 35(10): 193–203; (12): 233–44.
14. ONIONS, G. W. (1912). 'South African "Fertile" Worker Bees.' *Agric. J. Un. S. Afr.* 3(5): 720–8.
15. MUTTOO, R. N. (1957). 'Some So-called "Peculiarities" of Behaviour of Indian Honeybees Compared to the European Bees.' *Indian Bee J.* 19(3–4): 62–4.
16. KIAT, L. C. (1954). 'Beekeeping in Singapore.' *Glean. Bee Cult.* 82(11): 649–50, 657.
17. SINGH, S. (1957). *Final report of the bee-keeping research scheme, Punjab*, 1945–54 (Chandigarh: Controller of Printing and Stationery).

Chapter III

THE ANATOMY AND DEVELOPMENT OF THE HONEYBEE

The Head—The Thorax—The Legs—The Wings—The Abdomen—The Alimentary Canal—The Circulatory System—The Respiratory System—The Nervous System—The Reproductive Organs—Mating—Egg Laying—Development of Larvae and Pupae.

THE honeyhee is similar in structure to other insects, (1) its body being composed of three main parts, the *head* which carries the eyes, antennae and mouthparts, the *thorax* to which the legs and wings are attached, and the *abdomen* which is the largest and softest part. The body is covered with hairs, many of which are branching.

THE HEAD

The head is roughly triangular in shape when viewed from the front. At each side are the compound eyes. On the top, arranged in the form of a triangle, are three simple eyes. The compound eyes of the drone are larger than those of the worker, and those of the queen are smaller. The antennae are set with their bases close together in the centre of the head. Each has a basal stalk or scape and a number of short rings which make the flexible flagellum. Workers and queens have eleven short rings and tbe drones have twelve. The antennae are sensory organs responsive to touch and chemical stimuli. The mouthparts are composed of a pair of hard-biting parts, the mandibles, which can be seen from the front, and the proboscis or tongue which is a complex structure forming a tube for sucking up liquids sucb as nectar, honey or water. The outer part of the tube is formed of the two

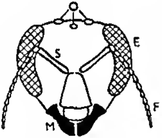


FIG. 2

HEAD OF WORKER BEE

O, Simple Eyes; E, Compound Eyes; S, Scape of Antennae; F, Flagellum of Antennae; M, Mandibles.

maxillae wbicb enclose the glossa, a tube which is tbe tongue proper, and the labial palpi which protect it. When not in use the proboscis is carried folded behind the base of the head. In the head are carried the salivary glands and tbe brood food glands wbich produce the royal jelly. The head is joined to the thorax by a slender neck whicb contains tbe oesophagus and a duct from the thoracic salivary glands.

THE THORAX

The thorax is a bard roundish structure composed of four closely attached segments. The interior is largely occupied by the muscles which operate the wings and legs and move the bead and abdomen together with their associated nervous systems. The first segment,

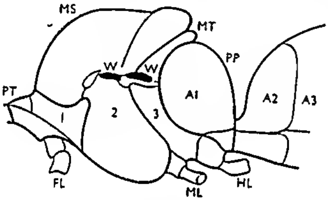


Fig. 3

THORAX

PT, Prothorax; MS, Mesothorax; MT, Metathorax; PP, Propodeum; W, Wing Base; FL, Fore Leg; ML, Middle Leg; HL, Hind Leg.

the prothorax, carries the first pair of legs, and is set like a collar on the front of the second segment, the mesothorax. The mesothorax is the largest part of the thorax and it carries the front wings and the middle legs. The third segment, the metathorax, is a narrow band closely wedged between the mesothorax and the fourth segment, the propodeum. The metathorax carries the hind wings and the hind legs. The propodeum is the back plate of the thorax and has no appendages.

THE LEGS

Each leg is composed of six principal parts, each connected to the next by a flexible joint. The first segment is the coxa, which is

attached to the thorax. The second is the trochanter, which is fairly short, and the third is the femur, long and narrow. The fourth is the tibia, which is adapted for specialized work; the fifth, the tarsus, has a large section called the basitarsus and four apical segments. The last is the pretarsus or foot which carries a pair of claws and a soft lobe for gripping smooth surfaces.

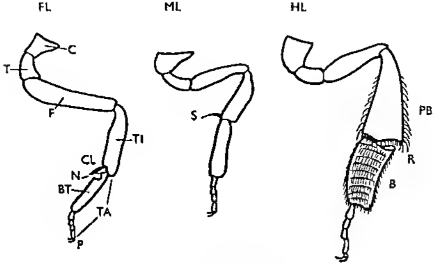


Fig. 4

LEGS OF WORKER BEES

FL, Fore Leg; ML, Middle Leg; HL, Hind Leg; C, Coxa; T, Trochanter; F, Femur; TI, Tibia; TA, Tarsus; BT, Basitarsus; P, Pretarsus; CL, Clasp; N, Notch; S, Spine; PB, Pollen Basket; R, Pollen Rake; B, Pollen Brush.

The basitarsus on each leg is equipped with stiff hairs which are used as brushes for cleaning the body, particularly for collecting the pollen which has become attached to the body hairs. The basitarsus of the front leg contains a notch, which is used in conjunction with a clasp on the end of the front tibia for cleaning the antennae. The inner side of the end of the tibia of the middle leg bears a spine, the purpose of which has not yet been determined. The hind tibia of the worker has a broader shape with a smooth concave outer surface fringed with long curved hairs. This is the pollen basket, in which the bee carries pollen to the hive. The pollen collected off the body by the front and middle legs is placed on the large flat brushes on the inner side of the hind basitarsi. The leg of one side is rubbed against the other so that a rake of spines at the end of the tibia collects the pollen off the opposite tarsal brush. The pollen caught by the rake lies in a deep notch between the tibia and tarsus. When

the tarsus is closed against the tibia the pollen is forced upwards into the pollen basket.

THE WINGS

The wings are flat two-layered extensions of the body wall strengthened by tubular veins. The large fore wing and smaller hind wing work together in flight because when the wings are extended, a row of upturned hooks or hamuli on the leading edge of the hind wing engages with a fold on the rear edge of the fore wing. The wings are attached a little way out from their roots to the side walls of the thorax but the roots are attached to the edges of the top of the thorax. Powerful muscles in the thorax raise and lower the top of the thorax a little. This action raises and lowers the innermost ends of the wings and as the side walls act as a fulcrum, the wings are forced up and down. As the wing descends, the front edge goes forward and downward and on the upstroke the action is reversed, forcing the bee forward through the air.

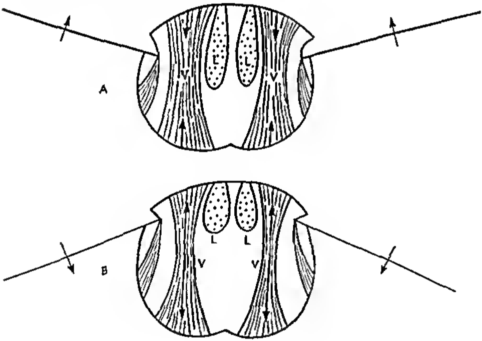


Fig. 5

MOVEMENT OF WINGS

A, Upward movement of wings, vertical muscles contracting;
B, Downward movement of wings, vertical muscles relaxing, lengthwise muscles contracting.
L, Lengthwise muscles; V, Vertical muscles.

THE ABDOMEN

The bee larva has ten abdominal segments but in the pupal stage the first one is transferred to the thorax becoming the propodeum. In queen and worker, six segments are clearly visible, the remaining three being so reduced in size and altered in form as to be unrecognizable. In the drone, seven abdominal segments are visible. Each segment is composed of two plates, a large one on top called the tergum and a smaller one on the underside called the sternum. The plates of each segment overlap those of the segment behind and the terga overlap the sterna. The plates are connected by infolded membranes so that the abdomen is able to expand and contract in both lengthwise and vertical directions. This can be observed when the bee is breathing strongly.

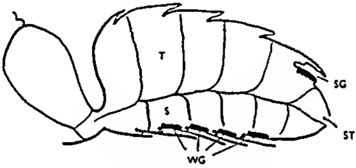


FIG. 6

SECTION OF ABDOMEN

T, Tergum; S, Sternum; SG, Scent Gland; ST, Sting; WG, Wax Glands.

The underneath of the sterna of the third, fourth, fifth and sixth segments are completely overlapped by extensions of the previous sternum in each case. Each extension covers two polished oval spaces on the interior of which are located the wax glands. The wax is discharged as a liquid and, as it lies in the pocket formed between the polished areas and the extension of the previous sternum, it hardens into small flakes.

On top of the tergum of the last segment, usually covered by the extension of the previous segment, is the scent gland. To release the scent, the bee raises the abdomen, exposing the scent gland, and fans with its wings.

The sting of the bee is a modification of the ovipositor for the injection of poison instead of eggs. It is carried in a chamber at the

end of the abdomen from which only the sharp-pointed shaft protrudes. The shaft is composed of three pieces, the tapering stylet which is on top, and two barbed lancets. The lancets slide freely in grooves in the stylet and enclose the poison canal. When a bee stings, the end of the abdomen is bent downward and with a sudden jab the shaft is thrust into the victim. The lancets are thrust alternately deeper into the skin, the barbs holding each gain. Poison from the poison sac at the base of the sting is pumped down the canal and out through a cleft near the end of the lancets. The action of the sting apparatus continues even after it has been separated from the body of the bee.

THE ALIMENTARY CANAL

The food tract begins with the mouth and ends with the anus in the sting cavity. Behind the mouth is a cavity in the head forming the sucking pump. The pump narrows into the slender oesophagus

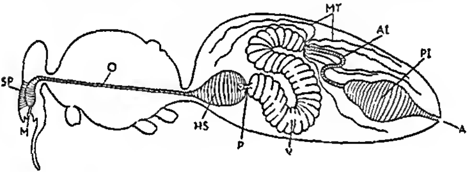


Fig. 7

ALIMENTARY CANAL

M, Mouth; SP, Sucking Pump; O, Oesophagus; HS, Honey Stomach; P, Proventriculus; V, Ventriculus (Stomach); MT, Malpighian Tubules; AI, Anterior Intestine; PI, Posterior Intestine; A, Anus.

which passes through the neck and thorax into the abdomen. At the front end of the abdomen the oesopbagus enlarges into the honey stomach, corresponding to the crop in other insects. It is in this honey stomach that the bee carries nectar or water or honey. Behind the honey stomach is a narrow neck called the proventriculus which acts as a valve controlling the passage of food. Then comes a large cylindrical sac, the ventriculus, the true stomach of the insect. After the stomach comes the narrow anterior intestine followed by the large posterior intestine or rectum at the extremity of which is the

anus. Where the ventriculus joins the intestine a number of long thin tubes are attached. These are the malpighian tubules.

The honey stomach is purely for carrying or storing liquids; it is not a digestive organ. Digestive juices and enzymes are secreted in the ventriculus and the products of digestion pass through the interior membrane and the stomach wall into the blood stream. The intestine serves principally for the discharge of waste matter and the absorption of water, and the rectum for the storage of faeces until the latter can be evacuated outside the hive. The malpighian tubules extract the waste products of metabolism from the blood and discharge them into the intestine.

THE CIRCULATORY SYSTEM

The products of digestion are carried by the blood to the various organs and tissues. The blood also transports the waste products of metabolism which are removed by the excretory organs, and carbon dioxide which is removed by the respiratory organs. The blood carries very little oxygen and is pale amber in colour.

The circulation is caused by the pulsations of a single long thin blood vessel running forward from the centre of the back of the abdomen, through the thorax and into the head. The abdominal section having muscular walls is the heart. The blood, which flows freely in all parts of the body, enters the heart through five pairs of slits in its walls. The pulsations of the heart drive the blood forward through the thoracic section, the aorta, to the brain. This action is assisted by the pulsations of a thin membrane supporting the heart and called the dorsal diaphragm. In the lower part of the body above the nerve cord there is another diaphragm which assists the backward flow of the blood. Food products not immediately required by the insect are stored in fat bodies scattered all through the body cavity and particularly in the abdomen.

THE RESPIRATORY SYSTEM

Oxygen is conducted to the tissues by numerous minute branching tubes which are really inward extensions of the body walls. The tubes or tracheae are more or less rigid owing to the spiral thickening in the walls but parts of the tracheae enlarge into thin-walled air sacs which can expand and collapse. The tracheae start at the spiracles, which are small breathing pores along the sides of the body, three on each side of the thorax and six on the abdomen. The first and largest is between the prothorax and the mesothorax and it can

be entered by the parasitic mites which cause acarine disease. After much branching the tracheae end in minnte tubes called tracheoles which terminate in or against the cells of the tissues. The ends of the tracheoles contain a liquid which absorbs oxygen and passes it on to the protoplasm of the cells. Tbe carbon dioxide produced is carried off by the blood and diffused througb the tracbeae and softer parts of the body wall.

THE NERVOUS SYSTEM

The central nervous system of the bee consists of a brain in the head and a ventral nerve cord in the lower part of the body extending from the head to the rear of the abdomen. Along the ventral nerve cord are a number of nerve masses, ganglia, united by paired connectives.

The brain receives the sensory nerves from the eyes and antennae. In the lower part of the head is a large ganglion supplying nerves to the feeding organs. The first body ganglion is in the prothorax and is associated with that segment. The second, in the rear of the thorax, supplies nerves to the mesothorax, metathorax, propodeum and first abdominal segment. The first three of the five ganglia in the abdomen are each associated with one segment. The fourth supplies nerves to two segments, and the fifth is connected with the remainder.

The sensory nerves join the receptive cells of the sense organs to the central nervous system. The organs of touch are certain hairs, most numerous on the antennae, which are associated with sense cells. Some small thin-walled hairs are each enervated by a group of sense cells and are considered to be the organs of smell or taste. They occur on the antennae and near the mouth. Also on the antennae are numerous minute discs covering large groups of sense cells. These are supposed to be organs of smell. There are no known organs of hearing, though bees do react to sound vibrations.

THE REPRODUCTIVE ORGANS

The male reproductive system consists of a pair of testes lying in the sides of the abdomen and connected by ducts to two large mucous glands. The mucous glands open together into a long slender tube, the ejaculatory duct. The ejaculatory duct leads to the anterior end of a large complex structure, the penis.

The spermatozoa are produced in the testis from which they travel down the vas deferens to an enlarged part of the duct called the

seminal vesicle. Here they are temporarily stored with their heads buried in the soft walls of the vesicle. In the mating season they travel down the ejaculatory duct in a secretion from the mucous glands into the bulb of the penis.

The female reproductive organs are fully developed only in the queen. In the worker they are vestigial, and function only under exceptional circumstances. The ovaries are two large pear-shaped masses composed of numerous closely packed ovarioles. The ovarioles come together at the thick end of the ovary in a lateral oviduct. The two lateral oviducts unite into a short common oviduct which leads to the wide terminal vagina. On top of the vagina is a spherical body, the spermatheca, connected to the vagina by a short duct. Connected to the duct are a pair of spermathecal glands.

The eggs are developed from the female reproductive cells at the top of the ovarioles. The eggs develop by the absorption of nurse cells and the fully grown egg is coated with a thin shell. The shell is complete except for a minute opening left at one end for the entry of the spermatozoa.

MATING

Mating takes place on the wing. At the time of mating the sperm mass in the penis bulb of the drone is discharged by the eversion of the penis into the vaginal pouch of the female. The spermatozoa make their way up the spermathecal duct into the spermatheca where they are stored and retain their vitality throughout the productive life of the queen. The queen may mate with several drones before she has enough spermatozoa and sometimes she is seen returning to the hive with the penis bulb still attached to her. It has been learnt that during the first twenty days or so of the young queen's life, the spermatheca contains a fluid that can accept the spermatozoa. If after about twenty days no spermatozoa have been received, this fluid solidifies. Thus, unless a virgin is mated within the first twenty days or so of her life, she becomes incapable of being mated properly. A properly mated queen has enough spermatozoa stored in her spermatheca to last her for two or three years of heavy egg laying.

EGG LAYING

The egg, when mature, is released from the ovary and travels down the oviducts. As it does so, the nucleus of the egg undergoes two divisions. In each case one of the nuclei persists and the other is absorbed. The first division reduces the number of chromosomes

in the nucleus from the thirty-two normal to female honeybees to sixteen. In the second division the chromosomes themselves split so that sixteen remain. If the egg is laid without receiving a spermatozoon, it will develop into a male bee or drone. But those eggs which are to develop into worker or queen bees are fertilized with a spermatozoon, also having sixteen chromosomes. The combination of the egg and sperm nuclei raises the number of chromosomes to thirty-two and such an egg develops into a female bee. The queen can thus lay either male or female eggs by withholding or releasing spermatozoa when the egg is being laid.

A normal healthy young queen lays drone eggs only at the beginning of and during the reproductive or swarming season. Even then most of the eggs are female. The queen walks over the combs, selecting cells into which to lay. After examining a cell with her antennae, she turns round, lowers her abdomen into it and deposits an egg at the bottom. When the egg is newly laid it stands perpendicular to the base of the cell, but as it develops it slowly leans over until, by the time the young larva is ready to hatch out, the egg is lying flat on the base of the cell.

Should the queen exhaust the supply of spermatozoa, then she can lay only drone eggs, and this is sometimes observed with an old queen. If a virgin fails to mate, then she will lay only drone eggs. Laying workers develop in a colony if it is queenless for some time. The ovaries of some of the workers develop and they lay drone eggs, often several of them in one cell. These eggs are usually laid in worker cells and the result is a lot of stunted drones. Sometimes, particularly with the variety *intermissa*, laying workers will produce female eggs (2) (3) (4). This could come about if the reduction division of the egg nucleus failed to take place.

THE DEVELOPMENT OF LARVAE AND PUPAE

The larva, worker, queen or drone, hatches after three days. For the next two and a half days all larvae receive the special food which is produced by the brood food glands in the heads of young workers. The minute larvae are given such an abundance of this food that they literally float in it. After two and a half days of this type of feeding, the young female larvae which are destined to become workers are fed with honey and pollen for another two and a half days. During this time they are not given more than they can eat at any one time, in fact they are given a carefully controlled ration. It is this controlled feeding together with the action of hormones that produces the under-developed female that is the worker.

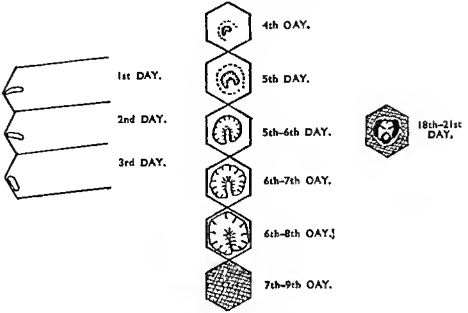


Fig. 8

STAGES IN EGG AND LARVAL DEVELOPMENT OF WORKER

Feeding completed, the cells are capped over with a porous wax cover on the ninth day after the egg was laid. On the twelfth day, after spinning a cocoon in the cell, the larva pupates. Twenty-one days after the egg was laid the young worker hee hites away the cap of the cell and emerges. This timing is correct for *mellifera* in temperate climates, hut as is often the case, hot climates cause more rapid development, and observations made on tbe African *adansoni* show that the cells are sealed on the eighth day and emergence takes place on the nineteenth or twentieth day (5). The *indica* hee bas a sligbtly more rapid rate of development, the cells heing sealed seven to eight days after the egg was laid and emergence taking place after eighteen or nineteen days (6).

The young larva destined to become a fully developed female or queen is fed with a superahundance of the special hrood food for four and a half to five days. On the eighth day after the egg was laid the queen cell is sealed. The larva spins its cocoon and, after a period of rest, pupates. Fifteen to sixteen days after the egg was laid, the young virgin bites round tbe cap of the cell and emerges. These periods appear to be the same for European, African and Asian races.

The development of the drone is similar to that of the worker but takes longer. Feeding takes six to seven days, tbe cell being capped

on the tenth day. After spinning the cocoon and pupating, the young drone emerges about twenty-four days after the egg was laid. The cap on a sealed drone cell is dome-shaped like the point of a pistol bullet, easily distinguished from a sealed worker cell which is flat-capped.

The above periods are important when considering the intensive management of frame hives, so the relevant times are set out in the following table for easy reference.

	WORKER			QUEEN	DRONE
	mellifera	*adansoni*	*indica*		
Egg hatches after	3	3	3	3	3 days
Cell sealed after	8–9	7–8	7–8	8	10 days
Bee emerges after	20–21	19–20	18–19	15–16	24 days

REFERENCES

1. SNODGRASS, R. E. (1949). 'The Anatomy of the Honey Bee,' pp. 473–518 of *The Hive and the Honeybee* (Hamilton, Ill.: Dadant).
2. HEWITT, J. (1892). 'Fertile Workers—Their Utility.' *J. Hort. Lond.* 25(3): 134.
3. ONIONS, G. W. (1912). 'South African "Fertile" Worker Bees.' *Agric. J. Un. S. Afr.* 3(5): 720–8.
4. MACKENSEN, O. (1943). 'The Occurrence of Parthenogenetic Females in Some Strains of Honeybee.' *J. Econ. Ent.* 36: 465–7.
5. SMITH, F. G. (1958). 'Beekeeping Observations in Tanganyika, 1949–57.' *Bee World* 39(2): 29–36.
6. MUTTOO, R. N. (1956). 'Facts about beekeeping in India.' *Bee World* 37(7): 125–33.

Chapter IV

THE BEHAVIOUR OF BEES

The Division of Labour—Vision—Hearing—Taste and Smell—Location — Communication — Nutrition — Foraging — Temperature Control—Water Requirements—Colony Defence——Swarming—Supersedure—Emergency Queens—Absconding and Migration.

THE DIVISION OF LABOUR (1) (2)

ALTHOUGH the worker is regarded as an under-developed female in that her ovaries are merely vestigial, other organs required by the worker for her specialized duties are highly developed. Some of these reach the peak of development at a particular age in the bee's life or when the needs of the colony demand their use.

The young bees spend most of their time in the hive either resting or patrolling and the first work they do is cleaning out cells. This is a major activity during the first five days or so but they will continue this work on a small scale even when they have begun foraging.

Early on, the brood food glands in the head develop, and the young bees are able to feed the young larvae with the special food with a high protein content, known as brood food or royal jelly. Until they are about three weeks old, the young bees may also feed the older larvae.

After a few days of this work, young bees take short flights round the hive to develop their powers of flight and to get the bearings of the hive. Their wax glands develop next, and the bees at this stage are occupied in any comb building or capping of cells that is required. The brood food glands and the wax glands may be developed in an individual both at the same time, but the older nurse bees tend to work more on comb construction, and the brood food glands become reduced in size. They also clear the hive of debris and help to store and ripen honey. Honey is ripened by adding enzymes which break down the sucrose in the nectar to dextrose and levulose, and by exposing the nectar to warm air in the hive to evaporate the excess moisture.

Not all the bees take a turn at guard duties, but those that do have their poison glands highly developed. Bees on guard are ready

to fly to the attack at the least disturbance. Their sting is most effective, but they only sting in defence of the colony or if they themselves are in danger. The sting is barbed and once it has been driven into the skin of an animal the bee is seldom able to withdraw it. As the bee wrenches itself away the complete sting together with the poison glands, muscles and nerve centre are left behind and the whole unit carries on working independently, going further into the flesh and at the same time pumping in poison. The bee itself dies soon after losing its sting.

The young bees are ready to start foraging at between ten and eighteen days after emergence, according to the requirements of the hive. As their bodies are still covered with hairs they often start by collecting pollen. The pollen adheres to the hairs of the body and is scraped off with the legs and packed into the pollen baskets and so carried to the hive. In the hive the pollen collector finds a suitable cell and brushes off the two pellets of pollen into it, leaving it to be packed by one of the hive bees.

Later, when the hairs are mostly worn off, the bees collect nectar, water and propolis. The nectar, and also the water, is sucked up through the mouth and held in the honey stomach. On arriving in the hive, the foraging bee regurgitates the nectar, passing it to one of the hive bees who puts it in a cell for ripening. Propolis is carried only lightly packed in the pollen baskets.

VISION (1)

The drones show the highest development of the eyes. This may be necessary so that they can spot a virgin out on her mating flight. The eyes of the worker do not have the acuteness of vision to stationary objects that is possessed by the human eye, but they are very sensitive to movement, which is of great importance in the defence of the hive against enemies. Their perception in the dark is quite good, but apparently not as good as the human eye. Bees can distinguish between an object having a pattern on its surface and a plain object. They can distinguish between a hollow square and a solid one of the same size, but not between a hollow square, X or Y of the same size, nor between a solid circle, square and triangle. It appears that the amount by which the light is broken up by the pattern is of greater importance than the shape of the pattern. While bees cannot distinguish between different shades of grey, they can distinguish between different colours, but not between different brightnesses of the same colour. Their eyes are unable to recognize red but they can see ultra-violet.

A characteristic of the vision of bees which human eyes do not possess is the ability to see the polarization of light. The light reflected by blue sky is partly polarized and the degree of polarization is least in that part of the sky nearest the sun and most at right angles to the sun. The planes of polarization are in the form of circles with the sun as centre. The purpose of the three simple eyes on top of the head has not been determined. When the compound eyes are blacked over the bees act as though blind, but when only the simple eyes are covered their behaviour does not appear to be affected.

HEARING (1)

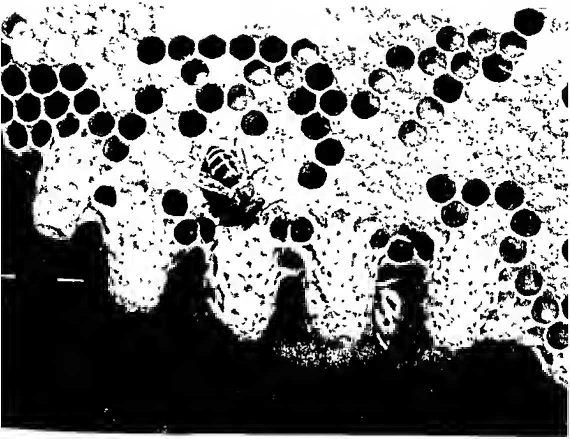
Research has not produced any conclusive evidence that the bee can hear sounds in the manner perceptible to humans. However, their legs appear to be responsive to high-frequency vibrations. Young queens produce a thin piping noise, pressing themselves against the comb as they do so. This is believed to be produced by air being blown through the spiracles. If there are two or more virgins in a hive, even if some are still in their cells, they can be heard piping in response to each other. Workers also produce a piping noise, though fainter.

The reaction of a swarm in flight to 'tanging', the beating of metal trays or tins, appears to be based on sound perception. Tanging has long been practised in Europe to make a swarm in flight settle. It has also been done successfully with the *adansoni* bees, to the great astonishment of the African onlookers who saw the swarm change direction in flight and cluster, in response to the vigorous beating of an empty four-gallon petrol tin. It is possible that certain high-frequency vibrations produced by tanging interfere with the vibrations produced by a swarm in flight.

TASTE AND SMELL (1)

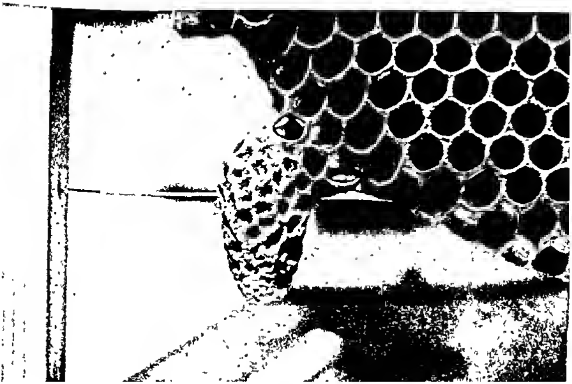
Organs of taste exist in the mouth and at the end of the antennae. They may also be present on the front legs. The organs of smell are confined to the last eight segments of the antennae. The bees can distinguish between different concentrations of sugar and their perception of differences in scents and mixtures of scents is high. They are also able to detect water at a distance. The acute perception of water by bees in the tropics is familiar to travellers in dry areas. The rapidity with which bees arrive around a leaking car radiator or open water container is as remarkable as it is inconvenient.

The perception of sugar concentrations and different flower

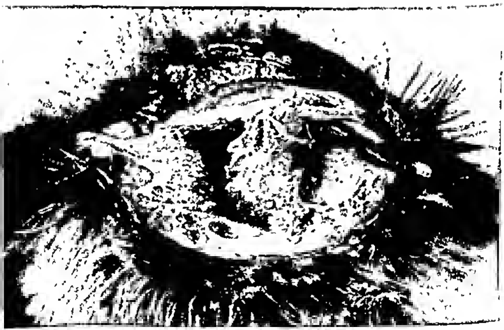


10. Emergency queen cells

11. A queen cell built under the swarming impulse



12. Healthy trachea of the first spiracle of the honeybee



13. Acarine disease. Trachea infested with *Acarapis woodi*

scents is of the utmost importance to the foraging hees, but there are other scents which alert and infuriate them. These reactions are defensive and are produced hy the smell of sweat, urine, horses, dogs and freshly turned earth. At night, the smell of a boney hadger or mongoose causes an alerted colony to produce an alarming hissing noise. Like animals, bees can also detect fear.

LOCATION (1)

Young hees make their first fligbts in front of the hive, facing it while they learn its form, colour and smell. Then they travel further afield learning the features of the countryside. Similarly tbey learn the location of a source of food. In returning to tbe hive they fly hack in tbe opposite direction from that in which they set out and for the same distance. Then they look for the familiar features of the hive's location. If the hive has heen moved, they come back to the place wbere the hive was and then start searching. It has been found tbat the bees use the sun for giving them their direction and they make compensation for the sun's movement in time. If the hive is moved into country unknown to the bees, more than ahout two miles, they will then reorientate tbemselves for the new position.

COMMUNICATION (1) (2)

Bees which find a source of nectar or pollen are able to pass on the information as to its location to others in the hive. This is done by means of dances on the combs and hy passing the smell of the source to the other bees. If the source is near the hive, the returning forager makes circular movements on the comh, first in one direction and then in the other. If the source is at a distance, the hee makes a different type of dance, a sort of flattened figure of eight with a straight run hetween turns. During the straigbt run, the bee shakes itself from side to side, and tbe more rapid the shakes the nearer is the source to the hive. Further, the number of shaking or waggle runs performed in a fixed period of time gives an accurate indication of the distance to the source. It has been observed that the angle between the straight run and the top of the comh is the same as the angle between the direction of the source of food and the sun, even when the sun is obscured by cloud.

This method of communication is common to *mellifera*, *adansoni* and *indica*, hut it has been observed recently by Lindauer (3) that whereas Carniolan bees change from the round dance to the figure of eight when the source is about 150 metres away from the hive,

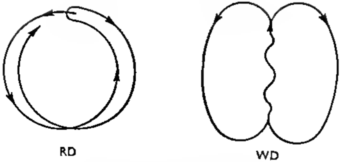


FIG. 9

DANCES OF HONEYBEES

RD, Round Dance; WD, Wag-Tail or Figure of Eight Dance.

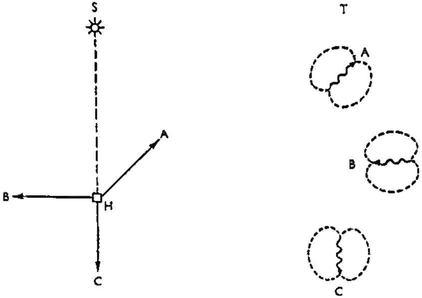


FIG. 10

HOW BEES INDICATE THE DIRECTION OF A SOURCE OF FOOD

S, Directions to sources A, B and C from hive (H) in relation to sun (S).
T, Manner of dancing on vertical comb to indicate direction to sources A, B and C in relation to top of comb (T).

indica in Ceylon makes the change when the source is only 2 metres away. The normal maximum distance *mellifera* is able to indicate is about 3 kilometres, roughly two miles, but the maximum distance *indica* was found to indicate was only 700 metres, less than half a mile, in Ceylon. The bees cannot indicate direction when the sun is

directly overhead but when the sun is two degrees or more from its zenith, the bees can give accurate orientation (4).

During experiments in Tanganyika, *adansoni* changed to the figure-of-eight dance when the source was 67 metres from the hive. The bees could not be enticed to feeding places beyond 600 metres, but were observed to be collecting food from palm trees 2,400 to 2,570 metres from the hive (5).

NUTRITION (2)

Bees obtain all their nutritional requirements from nectar, pollen and water. Nectar, after reduction to honey, is mainly carbohydrate, but it does contain a very little protein as well as vitamins and minerals. It serves as the energy-producing food for normal metabolism at rest or in flight. However, the brood food glands require additional products in order to produce royal jelly with its high protein content. This is obtained by eating pollen. As both egg laying and the feeding of young larvae are dependent on royal jelly production, brood rearing takes place only when pollen is available in the colony. In addition to pollen and nectar, water is required by the bees producing brood food.

Although bees can build comb if only honey or sugar are available, they cannot continue for long without pollen. Pollen is required for the continued functioning of the wax glands.

FORAGING (1) (2)

The bees find flowers by scent or by colour or by a combination of both. In the tropics, many important sources of nectar are inconspicuous and scent plays a most important part in attracting bees to them.

There are two classes of foragers, searchers and collectors. The searchers fly around visiting anything which might produce food, and they are most active early in the morning. Once they have found food they become collectors and continue to collect from the source they have found until it is exhausted. Most of the newcomers to a source of food arrive knowing its whereabouts and its scent, but not its shape or colour. The information as to whereabouts and scent has been obtained from the dances and food transference of the searchers and earlier collectors. If the source of food is found to yield only at a certain time of the day, the bees will return to it at that time on the next day.

While foraging, individual bees tend to concentrate on one species of plant, but a small proportion collect from two or more species on

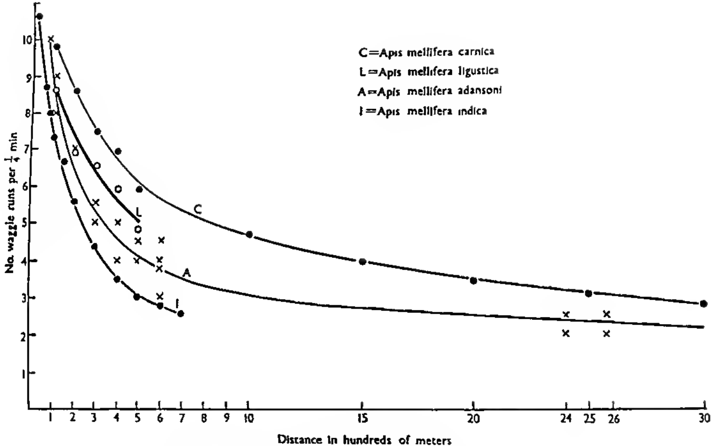


FIG. 11

COMPARISON BETWEEN THE DISTANCE INDICATION OF
:arnica (v. Frisch), *A.m. ligustica* (v. Frisch), *A.m. adansoni* (Smith) and *A.m. indica* (Lindauer).

a single trip. Not only do individuals tend to concentrate on one species, but they may concentrate on quite small areas, a single shrub or tree or a plot of herbs ten to thirty yards square.

Bees working on an orchard were found to have foraging areas up to forty yards across. Where the trees were planted in rows, a different variety in each row, and the spacing between the trees in each row closer than the spacing between rows, it was found that the individual bees tend to concentrate on one row and rarely visit the other rows.

It appears that the foraging area of an individual bee varies according to the intensity of the yield of food in an area and the degree of competition from other bees. If there are two or more sources of nectar yielding different concentrations of sugar in the nectar, the bees will work on the plants giving the highest proportion of sugar.

While bees have been known to fly to sources of food seven miles away from their hives, their normal foraging range is one and a half to two miles. It has been shown that the proportion of the forager's time which is spent in flying to and from the flowers has an important effect on the amount of crop harvested. In good weather, hives three-quarters of a mile from the flowers may obtain only 60 per cent of the honey surplus collected by hives sited in the midst of the flowers. In cool, cloudy or windy weather the difference may be much more marked, and a distance of three-quarters of a mile may result in the complete loss of the crop. The effect of the loss caused by time spent flying is more severe when the bees are able to gather their load of pollen or nectar quickly than when the collection takes longer (6).

TEMPERATURE CONTROL (1)

The temperature of the body of a bee is approximately that of the surrounding air, but activity will cause its temperature to rise. In cool climates when the air temperature falls below 18° C. (64° F.) the bees begin to form a cluster. The cluster is definitely formed at 13° C. (55° F.). The bees on the outside of the cluster remain still with their heads turned in towards the centre. In the centre of the cluster the bees generate heat by their own metabolism. The loss of heat from such a cluster by conduction is negligible, the main losses are by radiation and convection. When the air temperature falls, the size of the cluster contracts, reducing its radiating surface. When the temperature rises the cluster expands, increasing the radiation.

The temperature of the outside of the cluster should not fall below 10–12° C. (50–55° F.) though on the underside it may be as low as 9° C. (48° F.). Bees chill at 8° C. (46° F.) and fall from the

cluster. At the centre the temperature varies between 20° C. (68° F.) and 30° C. (86° F.) and never less than 17° C. (63° F.), but once brood rearing has hegun the temperature is maintained at between 31° C. and 35° C. (88–95° F.). The beat of the brood nest is generated by activity and metabolism.

In warm weather the heat is dispelled by fanning, and the hrood nest temperature does not rise ahove 36° C. (97° F.). In hot weather the hees hring in water which they spread on and in the cells of the comb and evaporate it hy fanning, reducing the temperature by the cooling effect of evaporation. Tbey also expose drops of water in their mouthparts to get the same effect. During a heavy honeyflow the evaporation of water from the nectar belps to cool the hive. Under extreme conditions the bees reduce the entrance to control the intake of hot air. When conditions are bad (40° C. or 104° F.) a lot of the bees will leave the hive and cluster outside. A colony that is overheated is irritahle and may attack *en masse* without provocation.

Due to its high specific heat, honey is a valuable buffer against sudden changes of temperature. In hot weather tbe air temperature may he at its maximum between 1 and 3 p.m. but the temperature in a hive with honey stores does not reach its maximum until between 5 and 7 p.m. and remains high until about midnight when it starts cooling.

WATER REQUIREMENTS (1) (7)

Water is collected practically every day, except during winter in cold climates, and very cold days when tbe bees cannot fly. Water is required for brood rearing; the more the number of larvae being fed the more the need for water. Little water is needed when the honeyflow is good, but more is required wben the flow is poor. Part of the water requirement is met from the water in nectar. More water is collected in the afternoon when the humidity of the atmosphere is low. The bees prefer to collect water which is warm, for instance from wet sand in the sunligbt.

The water collector passes the water to a hive hee. If the need for water is great, the hive bees solicit for it eagerly and take it quickly. This stimulates the collector to go for more. After handing over the water, the collector may do a dance and hefore going out to fetch some more water she stretches out her tongue to solicit food for the journey.

Water is as important to the existence of the honeyhee as nectar and pollen. When a hee goes foraging for nectar or pollen, not only can it take food for the outward journey hut it can feed as it forages

and cao feed on some of its load of nectar on the return journey. On rare occasioos boneybees have been observed foraging seven miles from their hive, but their normal range is about two miles. However, when a bee goes to collect water, the only food it gets is that with wbich it has stocked up before leaving the hive. Its range wbeo water collecting is therefore considerably less than wben foraging.

In those parts of the tropics which have a pronounced dry season wben there is neither nectar nor water available to tbe bees, the bee population appears to be migratory. During a long dry season with a complete absence of flowers, colonies that have food stores and can get water will remain in their hives. However, if the water supplies dry up, the bees consume their food at a tremendous rate, producing water by the combustion of the sugars, and then abscond, travelling to more favourable areas. Lack of permanent water is the major cause of the migration of bees in the deciduous forests and savannahs of the tropics (8) (9). Uoder hot dry conditioos in Australia it was found that each colony uses about ooe piot of water each day (10).

COLONY DEFENCE (1) (2)

The first esseotial of defence is the ability to recognize frieod from foe. The sense of smell plays the major role in tbe defence of the honeybee colony. In the hive tbe bees are continually passing food from one to anotber. Nectar brought in by a forager is transmitted from bee to bee and some of it may eveotually be stored in the comb. The result is that all the bees io the colony have a taste of all tbe food brougbt io. Because no two colonies forage in exactly the same area or bave differeot nectars in exactly the same proportion, no two colonies bave exactly the same odour. Tbus a bee can recognize by smell wbetber anotber bee is of her colony or is a stranger.

Numerous enemies attack bees in tbose parts of the tropics where honeybees are indigenous and the colonies are frequently on the alert. The guards of an alerted colony stand witb their mandibles open, front legs raised and antennae forward. They examine bees coming to the entrance witb their antennae whicb contain their organs of smell. A strange bee trying to enter will be closely examined and may be set upon by tbe guards. Robber bees approacb tbe entrance with a jerky motion and are often attacked by the guards as soon as tbey come near the entrance. Any intruders wbo get past the guard bees are treated to the same examination on the combs by the hive bees. If an intruder is submissive it may be dragged out of the bive, but if it tries to get away the guard will attempt to sting it and a fight develops.

Guard bees will attack objects moving in a jerky mannei and a colony that is fully alerted will attack any living creature that comes near or has a smell it dislikes. When the African and Asian honeybees are in a state of extreme alertness, they will produce a menacing hiss if an enemy comes near. If the intruder comes nearer they will attack in a mass. Once one bee has stung, the smell of the sting attracts the attack of more bees.

SWARMING (1) (2)

Swarming is the method of reproduction of the colony. What the stimulus is that starts the urge to swarm has not been determined. It has been found that the queen secretes a substance on her body which the hive bees obtain by licking her. This substance is passed round the hive by the habit bees have of feeding each other. So long as there is sufficient of this substance being produced by the queen to satisfy an adequate number of bees in the hive, no queen cells are constructed. However, if the supply of this queen substance diminishes below a certain level, or is lacking, then preparations will be made for raising a new queen. In a colony that has the swarming urge it is not clear whether the secretion of queen substance diminishes, or whether the bees refrain from collecting and distributing it.

Swarming is a powerful instinct, as is reproduction in all forms of life, and once this instinct has got a hold on a colony it has got to be satisfied. Swarming preparations start when the colony has built up to a considerable strength, though some strains will swarm when they are still small colonies. Often swarming is timed to coincide with the beginning of a honeyflow period, when there will be plenty of nectar for the new colony to establish itself and to lay in stores against the next period of dearth.

The first movement towards swarming is the laying of male eggs to provide drones to mate with the new queen. The presence of drone brood in the hive does not necessarily mean that the colony is going to make swarming preparations, but drones have to be produced, as well as large numbers of workers, before the colony can reproduce itself. The first definite sign of preparation for swarming is the appearance of queen cells. These are built round the edges and at the bottoms of the brood combs. As the queen cells develop, the queen of the colony eases off in her laying and fewer and fewer eggs and young larvae are to be found in the hive. When at least one of the queen larvae in the cells has completed feeding and the cell is sealed, the old queen, accompanied by a large number of bees, will

cells. Eggs in worker cells, or young larvae less than 2½ days old, which are still being fed on an abundance of brood food, are selected. Their cells are enlarged and extended downwards and the larvae fed in the same way as in normal queen cells.

ABSCONDING AND MIGRATION

Absconding is the complete desertion of the hive by the bees. Usually the hive is left with completely empty combs, but sometimes even brood and food are left. The most common causes of absconding are lack of water, exhaustion of food stores, overheating and continuous pest attack.

If a colony has ample stores but all water supplies within range dry up, the bees consume the honey very quickly and then migrate. But if there is sufficient food in the hive and water is available all through the dry season, the bees will remain in the hive. This behaviour is clearly demonstrated by the *odansoni* bees in the great deciduous woodland beekeeping areas of central Africa (8) (9).

If a colony becomes very short of stores, or is robbed of its honey, and there is little or no nectar available, the bees fill up with whatever honey remains and then they abscond. This is normal behaviour for *adonsoni* in Africa and also for *indica*, even in the rain forests of South India and Ceylon (3) (11). It is also observed occasionally in *mellifera*, but in the colder climates where it is usually found this bee tends to remain in its hive and die of starvation. This is not to be taken to mean that *odansoni* and *indica* do not die of starvation. A colony that has had to migrate through lack of water or food may go on travelling until all the food supplies in the bees' bodies are exhausted and it has to cluster. Such a swarm may be even too weak to collect the nectar available in the place it has reached, and the bees just fall away from the cluster one by one, dying of starvation. If a cluster in this condition is brushed into a box and sprinkled with sugar syrup, the bees will revive and commence foraging.

The next most common cause of absconding is persistent pest attack, particularly by ants. A weak colony will leave a hive if the wax moths have become well established. Similarly, if the nesting place becomes uninhabitable through overheating, either through being made of a material which does not provide enough insulation against the heat of the sun, or through lack of facilities for the provision of good ventilation, the bees will abscond. If *odansoni* bees are put into a hive full of frames containing complete sheets of foundation, they usually abscond, even if fed. It is not natural for a cluster to be split up by sheets of wax in this manner (9). Excessive interference

with the hive by a beekeeper may cause a colony to abscond. In such circumstances the beekeeper is classed as a pest.

Migratory swarms exhibit behaviour not usually encountered in reproductive swarms. On several occasions two or more swarms have been seen to amalgamate. The amalgamation may take place peacefully, or a battle may be waged for an hour or so before the swarms eventually combine or the incoming swarm is repelled. In a large combined swarm of this type there may be several queens; usually such a swarm, although it appears to be a peaceful cluster, will turn vicious if disturbed. Migratory swarms are usually easily hived, and if fed, will establish themselves. But combined swarms, containing more than one queen, will not remain in a hive until the queens have been reduced to one. Some swarms, even after they appear to have settled down in a hive, may abscond after a few hours or even after two or three days (9).

An established colony of bees, whether they be *mellifera*, *adansoni* or *indica*, will not abscond if they can get water, have plenty of food stores, are secure from the attack of pests, are in a strong healthy condition nnd in a well-ventilated hive shaded from the full heat of the midday and afternoon sun.

with the hive by a beekeeper may cause a colony to abscond. In such circumstances the beekeeper is classed as a pest.

Migratory swarms exhibit behaviour not usually encountered in reproductive swarms. On several occasions two or more swarms have been seen to amalgamate. The amalgamation may take place peacefully, or a battle may be waged for an hour or so before the swarms eventually combine or the incoming swarm is repelled. In a large combined swarm of this type there may be several queens; usually such a swarm, although it appears to be a peaceful cluster, will turn vicious if disturbed. Migratory swarms are usually easily hived, and if fed, will establish themselves. But combined swarms, containing more than one queen, will not remain in a hive until the queens have been reduced to one. Some swarms, even after they appear to have settled down in a hive, may abscond after a few hours or even after two or three days (9).

An established colony of bees, whether they be *mellifera*, *adansoni* or *indica*, will not abscond if they can get water, have plenty of food stores, are secure from the attack of pests, are in a strong healthy condition and in a well-ventilated hive shaded from the full heat of the midday and afternoon sun.

cells. Eggs in worker cells, or young larvae less than $2\frac{1}{2}$ days old, which are still being fed on an abundance of brood food, are selected. Their cells are enlarged and extended downwards and the larvae fed in the same way as in normal queen cells.

ABSCONDING AND MIGRATION

Absconding is the complete desertion of the hive by the bees. Usually the hive is left with completely empty combs, but sometimes even brood and food are left. The most common causes of absconding are lack of water, exhaustion of food stores, overheating and continuous pest attack.

If a colony has ample stores but all water supplies within range dry up, the bees consume the honey very quickly and then migrate. But if there is sufficient food in the hive and water is available all through the dry season, the bees will remain in the hive. This behaviour is clearly demonstrated by the *adansoni* bees in the great deciduous woodland beekeeping areas of central Africa (8) (9).

If a colony becomes very short of stores, or is robbed of its honey, and there is little or no nectar available, the bees fill up with whatever honey remains and then they abscond. This is normal behaviour for *adansoni* in Africa and also for *indica*, even in the rain forests of South India and Ceylon (3) (11). It is also observed occasionally in *mellifera*, but in the colder climates where it is usually found this bee tends to remain in its hive and die of starvation. This is not to be taken to mean that *adansoni* and *indica* do not die of starvation. A colony that has had to migrate through lack of water or food may go on travelling until all the food supplies in the bees' bodies are exhausted and it has to cluster. Such a swarm may be even too weak to collect the nectar available in the place it has reached, and the bees just fall away from the cluster one by one, dying of starvation. If a cluster in this condition is brushed into a box and sprinkled with sugar syrup, the bees will revive and commence foraging.

The next most common cause of absconding is persistent pest attack, particularly by ants. A weak colony will leave a hive if the wax moths have become well established. Similarly, if the nesting place becomes uninhabitable through overheating, either through being made of a material which does not provide enough insulation against the heat of the sun, or through lack of facilities for the provision of good ventilation, the bees will abscond. If *adansoni* bees are put into a hive full of frames containing complete sheets of foundation, they usually abscond, even if fed. It is not natural for a cluster to be split up by sheets of wax in this manner (9). Excessive interference

with the hive by a beekeeper may cause a colony to abscond. In such circumstances the beekeeper is classed as a pest.

Migratory swarms exhibit behaviour not usually encountered in reproductive swarms. On several occasions two or more swarms have been seeo to amalgamate. The amalgamation may take place peacefully, or a battle may be waged for an hour or so before the swarms eventually combine or tbe incoming swarm is repelled. Io a large combined swarm of this type there may be several queeos; usually such a swarm, although it appears to be a peaceful cluster, will turo vicious if disturbed. Migratory swarms are usually easily hived, aod if fed, will establish themselves. But combioed swarms, cootaining more than one queen, will not remain in a hive until the queens have been reduced to one. Some swarms, eveo after they appear to have settled down io a hive, may abscood after a few hours or even after two or three days (9).

An established colony of bees, whetber they be *mellifera, adansoni* or *indica*, will oot abscood if tbey can get water, have plenty of food stores, are secure from tbe attack of pests, are in a stroog healthy condition and in a well-ventilated hive shaded from the full heat of the midday and nfternoon sun.

REFERENCES

1. RIBBANDS, C. R. (1953). *The Behaviour and Social Life of Honeybees* (London: Bee Research Assoc.).
2. BUTLER, C. G. (1954). *The World of the Honeybee* (London: Collins).
3. LINDAUER, M. (1957). 'Communication Among the Honeybees and Stingless Bees of India.' *Bee World* 38(1): 3–14.
4. FRISCH, K. VON (1955). 'Beobachtungen und Versuche M. Lindauers an indischen Bienen.' *S.B. bayer. Akad. Wiss.* (10): 209–16.
5. SMITH, F. G. (1958). 'Communication and Foraging Range of the African Honeybees Compared with that of the European and Asian Bees.' *Bee World* 39(10): 249–52.
6. RIBBANDS, C. R. (1952). 'The Relation Between the Foraging Range of Honeybees and Their Honey Production.' *Bee World* 33(1): 2–6.
7. LINDAUER, M. (1955). 'The Water Economy and Temperature Regulation of the Honeybee Colony.' *Bee World* 36(4): 62–72; (5): 81–92; (6): 105–11.
8. SMITH, F. G. (1953). 'Beekeeping in the Tropics.' *Bee World* 34(12): 233–45.
9. SMITH, F. G. (1958). 'Beekeeping Observations in Tanganyika, 1949–57.' *Bee World* 39(2): 29–36.
10. RAYMENT, T. (1923). 'Through Australian eyes—Water in Cells.' *Amer. Bee J.* 63: 135–6.
11. MUTTOO, R. N. (1957). 'Some so-called "peculiarities" of behaviour of Indian honeybees as compared to the European bees.' *Indian Bee J.* 19(3–4): 62–4.

Chapter V

DISEASES AND ENEMIES OF BEES

Diseases—Acarine Disease—Nosema Disease—Amoeba Disease—American Foul Brood—European Foul Brood—Chalk Brood—Stone Brood—Sac Brood—Addled Brood—Enemies of Bees—The Honey Badger—Birds—Lizards, Toads and Frogs—Beetles—Moths—Wasps—Ants—The Bee Louse—Bee Poisoning.

DISEASES

THOSE parts of the tropics in which *Apis* is indigenous appear to be comparatively free from the various diseases of brood and adults which assail bees in more temperate climates. In the Union of South Africa there are *Nosema* disease and European Foul Brood but the former has not yet been detected north of the Union nor south of the Sahara, although European Foul Brood has been detected recently by the author in this region. In India the only disease discovered has been Acarine in the north, which cannot be considered as tropical. In the tropical regions of the New World, bee diseases do occur, but only sporadically (1).

There are several possible reasons for the apparent absence of diseases from the tropics of Asia and Africa. The first and most obvious one is that in these regions there are very few beekeepers with any knowledge of bee diseases. It must be borne in mind that only a very small proportion of the bees are kept in frame hives, the vast majority being wild colonies occupying natural cavities or very primitive hives. The honey hunters and owners of primitive hives may have seen diseased colonies while collecting their honey and beeswax crops but, not knowing the significance of what they have seen, have not reported it to anyone who might be interested.

Another explanation is that the prevalence of predators on the honeybee inhibits any spread of disease should it occur. Thus, disease recognizable as such does not occur in epidemic proportions, weak colonies being rapidly extinguished by the more obvious predators.

It has been suggested that climate is an inhibiting factor and there is evidence that this is so with *Nosema* disease and indications that this is so with Acarine. *Nosema* requires the conditions of the winter cluster for it to develop in a colony and Acarine has been confined to areas having particular climatic conditions, including the need for the winter cluster. However, American Foul Brood is known to be present in some of the Central and South American countries and for some years was a serious scourge in Hawaii, and European Foul Brood has recently been found in tropical Africa.

Acarine Disease

This disease, called 'Isle of Wight' when it first appeared in Britain, is caused by a mite, *Acarapis woodi* Rennie, which enters and breeds in the trachea of the honeybees. In the hive the mites migrate from the trachea in which they were bred and crawl into the trachea of young hive bees.

Acarine disease has been found only in North-west Europe, where it virtually wiped out the indigenous honeybees in Britain, in a small area of Argentina (2), in Uruguay (3) and in North India (4) (5) (6). These are all areas in which the midwinter temperature falls below 56° F. (13° C.). Some bees collected in the Belgian Congo have been found to be infested with the acarine mite but the locality of origin is not known (34).

The symptoms of the disease are bees with wings held at unusual angles, bees crawling in front of the hive, unable to fly and with abdomens distended with dysentery. Diagnosis is confirmed by examination of the trachea in the prothorax. The head and front legs are removed and then the prothorax chitin is carefully peeled off. The trachea from the first spiracle then lie exposed. Healthy trachea are whitish like the muscles and difficult to see. Diseased trachea are brown or speckled. If mites are present in the trachea they are easily seen under a low-power microscope (6) (7) (8) (9) (10).

Treatment is effected by preventing the mites from spreading to healthy bees in the hive and also by killing the mites themselves. Methylsalycilate, applied to a pad of cotton wool in a flat tin with a perforated lid and placed under the frames, prevents the spread of the disease within the colony. This method can be used at any time of the year and some beekeepers who operate where Acarine is prevalent keep methylsalycilate in the hives all the time. Nitrobenzine and methylsalycilate in equal volumes can be applied in the same way when there is no brood in the hive. The nitrobenzine is quicker in its action because it actually kills the mites. It is, however, disturbing to the colony and is said to be harmful to the brood. A colony with

a high proportion of hees infected is not likely to recover. It is hest to kill the hees outright and he done with it and so help to prevent the spread of the disease to other colonies.

Recent experiments with the new acaricides have shown that chlorohenzilate (Folbex) is the most effective in killing the mites with the least toxic effect on the bees (11). Two doses each of 350 to 450 mg. given eight days apart effect a complete cure. A method of application which has heen found effective is to soak hlotting-paper in 5 per cent potassium nitrate solution. Allow the hlotting-paper to dry and then soak it in a 15 per cent solution of chloro-henzilate in henzine and allow it to dry again. An 11 cm. hy 4 cm. strip of the hlotting-paper so treated then contains the approximate dose. The colony is treated hy lighting one strip at the end and allowing it to smoulder in the hive with the entrance shut after flying has ceased in the evening.

'*Nosema*' *Disease*

This disease is caused by a protozoon, *Nosema apis* Zander, which attacks the lining of the stomach. It is disseminated hy spores contained in the faeces dropped on the comhs hy infected bees who are confined to the hive during cold weather. The hive hees clean up the faeces and so swallow the spores which hecome active in the stomach. When the weather is warm enough for flying the hees void their faeces outside the hive and the chances of passing on the infection are greatly reduced (7).

Thus *Nosema* requires the climatic conditions which force the hees to form a cluster, or which confine the bees to the hive for a long period. While this disease is widespread in countries having cold winters, including the Union of South Africa, it has not heen found in countries having a tropical climate. However, in those parts of the tropics which have more or less continuous rain for long periods which prevents the hees from leaving the hive, conditions for the development of *Nosema* might exist.

Symptoms which may indicate the presence of *Nosema* are dysentery within the hive during the winter, dwindling or failure to huild up as rapidly as other colonies, dead hees on the ground in front of the hive, hees standing or lying ahout outside the hive with tremhling legs or wings. Diagnosis is confirmed hy microscopic examination of the contents of the stomach and intestines. The end of the ahdomen, the last segment, is cut off with a pair of sharp scissors and the intestine is withdrawn with a pair of fine forceps. The intestine is placed on a slide and spread out with a little water. When *Nosema* is present the spores are usually found in great

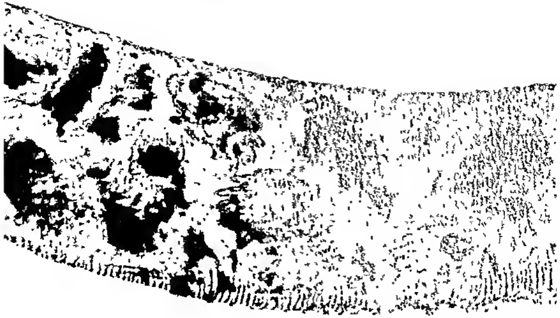
numbers. They are short cylindrical objects with rounded ends about 4 microns long and 2 microns broad (9).

As the house bees become infected when they clean up the combs after the cluster has broken up in the spring, the most effective treatment is to transfer the bees on to foundation or sterilized combs as early as possible in the flying season. The method recommended by Bailey (12) (13) is as follows. The queen with one comb of brood is placed in the centre of a clean brood chamber containing new frames of foundation. This chamber is placed over the old brood chamber containing all the remaining brood and stores, and separated from it by a queen excluder. The entrance to the old brood chamber is closed and a new entrance arranged directly into the new brood chamber above the excluder. The bees quickly remove the stores from the old combs in the chamber beneath the queen excluder, and draw out the foundation above the excluder. The old central comb, on which the queen had been transferred to the new chamber, is placed below as soon as there are eggs present in the new comb. Each week, any empty comb is removed and after four weeks all of it should have been emptied. The lower brood chamber, floor board and queen excluder are then removed and the bees on the new comb in the clean brood chamber are placed on a clean floor board.

The infected combs and brood chamber can be sterilized by placing rags or cotton waste soaked in ¼ to ½ pint of glacial acetic acid in an empty super above the brood chamber, making sure that the pile of boxes is properly closed underneath and on top to prevent wastage of the gas. The spores are killed after about forty-eight hours, but it is best to continue the fumigation for a week, followed by seven days airing. Formalin (40 per cent formaldehyde) can be used in exactly the same way but there must be no honey in the combs because formaldehyde makes honey permanently toxic. After airing, the fumigated combs can be returned to the bees. The floor board and crown board should also be fumigated. Care must be taken to ensure that the fumigation of the combs is thorough as there have been cases of the disease occurring after fumigated combs have been given to the bees.

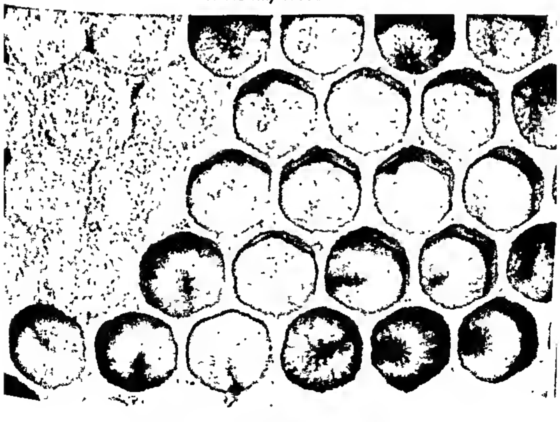
Amoeba Disease

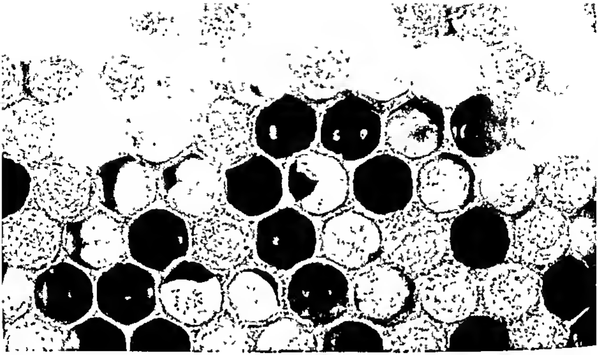
The causative organism of this disease is *Malpighamoeba mellificae* Prell which infests the malpighian tubules. It is an amoeba which, when mature, forms into cysts which pass into the intestine and are voided with the faeces. The amoebae take 3½ to 4 weeks to mature into cysts, and as this disease is frequently associated with *Nosema*,



14. Acarine disease. Section of trachea showing mites inside

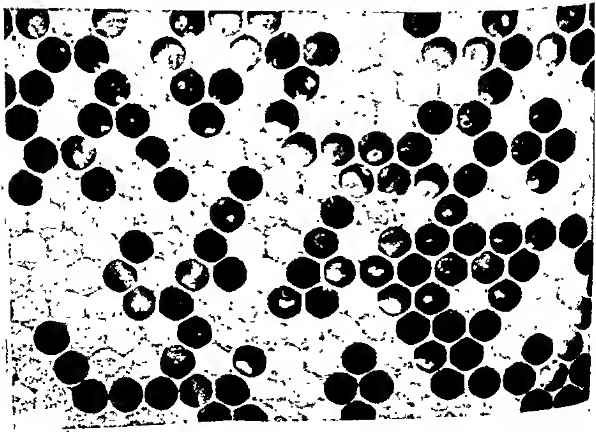
15. Healthy brood





16. European foul brood. Note the unsealed larvae in odd positions in the cells and decaying

17. European foul brood. Note the general irregularity of the sealed brood and dead and decaying larvae



brood. The larvae die after the cells have been capped and then turn a chocolate-brown colour. At a later stage the larval remains become a ropy mess in the cell. Finally, the remains dry into a hard scale fixed to the cell walls and can only be removed by the bees with great difficulty. The disease produces a foul smell in the hive, hence its name.

For microscopic examination, a scale or a little ropy slime is rubbed up with water on a clean slide. A drop of negative stain, nigrosin, is placed on another slide and a drop of the watery suspension added to it. The mixture is spread thinly over the slide and allowed to dry. Examination under a $\times 100$ oil immersion objective shows the spores as colourless objects against the dark background of the stain. In the early stages only rods are found, but the spores are forming in the ropy stage and the dry scale is a mass of spores. The spores have a characteristic shape, rounded at the ends, about 1·3 microns long by 0·5 microns wide (9).

The treatment in the case of a *mild* infection is to dust all the combs in the hive with pulverized sulphathiazole. This is done very easily with a small dusting pump. Treatment should be repeated every ten days until all signs of the disease have disappeared. The dusting of the combs is more effective than the feeding of sulphathiazole in syrup.

In serious cases, if the bees are strong, they can be shaken off the combs over newspapers and allowed to run into an empty hive containing only foundation and standing on the site of the original hive. The newspapers are gathered up and burned in a pit together with the combs. The pit is then carefully filled in to prevent any bees getting at the remains. The hive itself which had contained the diseased colony is scorched all over with a blowlamp to kill any remaining spores. Twenty-four hours after shaking, by which time the bees will have consumed any infected honey they might have had in their crops, the bees are fed sugar with one 0·5 gramme tablet of sulphathiazole crushed up in each five to seven pounds of sugar syrup. Every precaution must be taken to prevent bees from robbing infected material and it is best to carry out the shaking operation in the late evening. No honey or any comb from an infected stock should be given to another hive. Honey containing spores is perfectly harmless to human beings.

If the colony is not a strong one, then the bees also should be destroyed. During the day, make sure that there are no holes in the hive, other than the entrance, through which bees can escape. At night, when all the bees are in the hive, close the entrance and pour a pint of petrol in through the feed hole. Close the feed hole and

leave the hive alone for a few minutes. Dig a hole and put some straw or paper in it. Bring the hive near the hole and put in all the frames and the dead bees. Set fire to the lot, and when the combs are all burnt, bury them. All propolis and wax should be scraped off on to newspaper and the paper and scrapings burnt. The hive should then be scorched all over with a blowlamp (18) (19).

European Foul Brood

The first and most conspicuous organism found in larvae killed by this disease is *Bacillus pluton* White and at later stages other bacterial forms known as *B. eurydice*, *B. alvei* and *Streptococcus apis* appear as associates (7). However, recent findings by Bailey (20) indicate that European Foul Brood is caused by the growth of both *Streptococcus pluton* and *Bacterium eurydice*, and that either bacterium alone is not pathogenic. Bailey's studies of the causative organisms of European Foul Brood show that *pluton* appears in different forms. Until recently each of these forms was given a different name, but Bailey considers that the more accurate designation of this organism is *Streptococcus pluton* rather than *Bacillus pluton*.

European Foul Brood had not been found in the tropics until recently (21), but in Europe and North America there are occasional outbreaks, sometimes on a large scale affecting a large proportion of colonies in an area. It is also reported present in the Union of South Africa.

The symptoms are dead larvae in the cells in unnatural positions, and turning chocolate-brown. The larvae die before the cells are capped, become granular and then harden into scales which are loose in the cells. Whereas American Foul Brood usually occurs in strong colonies which have picked up the disease through robbing infected colonies, European Foul Brood normally occurs in small colonies (15).

The procedure for microscopic diagnosis is exactly the same as for American Foul Brood. *S. pluton* appears as ovoid cocci with characteristic somewhat pointed ends varying in size from 1·3 by 1 micron to 0·7 by 0·5 micron. They may be single, in short chains or rosettes. In advanced decomposition the rods of *B. eurydice* and cocci of *B. alvei* and *Streptococcus apis* may also be observed (9).

Another test for distinguishing American from European Foul Brood is based on the fact that both *B. larvae* and *S. pluton* cause milk to coagulate, but at different rates. Two drops of fresh milk are placed on a slide. A dried scale is placed in the milk on the slide and stirred up with a matchstick for about ten seconds. The time taken from when the scale was added to the milk to when a firm curd is

formed is noted. If it is a case of A.F.B. the time is about thirty seconds, never more than sixty. If it is E.F.B., it is longer, between eighty and one hundred and twenty seconds (9).

The treatment is destruction of bees and combs by burning, followed by burying the burnt material as described under American Foul Brood. The hives should be scorched with a blowlamp. Success has been obtained in curing European Foul Brood with streptomycin and terramycin fed to colonies in sugar syrup. But as European Foul Brood has the disconcerting habit of reappearing in apiaries a year or two after it has apparently been eradicated, it is considered wiser to destroy infected colonies (18) (19).

Chalk Brood

This is a fungus disease, caused by *Pericystis apis* Maassen, which attacks the larvae and converts them into chalk-white masses of mycelium. The larvae die soon after the cells have been capped. The bees remove the cappings, but at first the larvae completely fill the cells and are rubber-like. Later they shrink and become tough and loose in the cells. Sometimes they assume a greenish-brown or black colour due to the formation of fruiting bodies. The fruiting bodies are large cysts, 300 to 400 microns in diameter, and they contain numerous spore balls 20 to 30 microns in diameter (9) (22).

Normally the bees themselves are able to keep this disease under control, but if the outbreak is very heavy, the worst combs should be destroyed and the bees transferred to a clean hive. The old hive should be scraped clean and treated with a blowlamp. Dampness and bad ventilation in the hive should be avoided.

Stone Brood

Also a fungus disease, it is caused by *Aspergillus flavus* Link ex. Fr. and *A. fumigatus* Fres. The larvae are turned into hard stone-like objects lying in open cells. Adults may also be attacked and killed. Infection takes place by the germination of the spores in the alimentary canal. Combs and equipment can be disinfected by exposure to formaldehyde gas by the method recommended for the sterilization of *Nosema*-infected hives (9) (22).

Sac Brood

The larvae die after becoming fully grown and the cells sealed. They become sac-like with a tough skin filled with a watery granular fluid. Later they dry into loose scales. Believed to be caused by a virus, the disease is seldom serious and usually passes away without treatment (7).

Addled Brood

This is a genetical disorder which can he overcome by re-queening with a different strain. The larvae die and decompose, but do not hecome ropy as in A.F.B. They may pupate but the pupae are undersized (7).

ENEMIES OF BEES

There is no doubt that the greatest enemy of the honeybee is Man. He destroys colonies wholesale by completely robbing them of all their food as well as eating their brood. Even when he has advanced to frame hive beekeeping he upsets the colony balance by unnecessary interference with the brood nest, taking too much honey, and spreading hee diseases. Added to that he poisons the bees hy spraying the flowers, their source of food, with insecticides. Nevertheless, man is well supported by animals, hirds, reptiles and insects, all of which regard the hees and their products as fair prey. The honeybee is not exactly powerless against its enemies and occasionally it gets its revenge on man; unfortunately it is usually quite innocent parties who suffer. Provided that the colony is strong, it can keep its predators under control. It is, however, liable to be swamped by mass-attacks such as are made by ants, and there is nothing that the bees can do ahout the sting-proof hide of the honey hadger if the hive is not strong enough to withstand the badger's claws.

The Honey Badger

The honey badger or ratel, *Mellivora capensis*, is a powerful animal about three feet long, with a very tough skin and wicked claws. The top of its back is covered with a wide whitish area which is surrounded by a white line. The rest of the body is dark. This animal breaks up beehives and steals all the comb without being worried by stings. It is very dangerous at close quarters, and if you come across it, get out of its way unless you can put a rifle bullet into it. It knows no fear, attacks with a hissing snarl, has very powerful front legs armed with long claws and it goes for the tenderest parts. It can push heavy hives off stands and smash up timber seven-eighths of an inch thick. It may be followed in its depredations by the giant white-tailed mongoose, and the civet cat, which, like jackals after a lion, eat up whatever the ratel leaves.

The honey badger seems to be distributed throughout tropical Africa south of the Sahara. In Java (23) the yellow-throated marten, *Charronia flavigula robinsoni*, also of the family Mustelidae, attacks hives in a similar manner. In Manchuria *C. flavigula* is known as the honey dog.

African beekeepers protect their hives hy hanging them from the branches of erect, smooth-barked trees. Sometimes tbey pile thorn bushes round tbe bottom of the tree. It has been found that if tbe apiary is surrounded by a strong wire netting, the bottom of which is buried in the ground to the depth of one foot and turned outwards for one foot underground, it prnvides satisfactory protection. Even better protection is afforded hy keeping the hives in a strongly built bee house.

Birds

Tbere is not much one can do about hirds. They usually catch and eat flying bees. Some tap the hive near its entrance with their beaks and wait for a bee to come nut to investigate. The honey-guides occur in Africa south of the Sahara, in the Himalayas and in Burma, Siam, Malaya, Sumatra and Bornen (24). The greater honey-guide, *Indicator indicator*, leads humans and ratels to bees' nests. The bird flies ahead, swooping from tree to tree and making a chattering noise. It will wait quietly nearhy while the man, or ratel, breaks open the nest and takes out the comh. When the man, or ratel, leaves, the bird comes down and eats some of the remaining comb. There is a tradition among African honey hunters that the bird must reeeive its share of the eomb or next time it will lead the honey hunter into danger. It has been found that it can digest beeswax. Other species of *Indicator*, which do not appear tn guide, have also been found to have beeswax in their gizzards. Bee eaters can be shot if they become a serious pest in an apiary.

Lizards, Toads and Frogs

Lizards will lurk near tbe entrances of hives and often make the bees bad-tempered. If the hives are on the ground, toads and frogs may be a nuisance, but not if the hives are on proper stands. The bees make menacing darts at lizards near the entrance, but I have known tbem kill a lizard only when it has actually entered the hive.

Beetles

Tbere are two classes of beetle that enter beehives, tbose that come to steal honey and those which come to hreed. The former can be a nuisance, particularly in weak colonies, and large numbers of them may be found on tbe honeycombs. As they are usually larger than tbe bees, the best protection is to reduce tbe heigbt of the entrance to three-eighths of an inch, which allows free passage for tbe bees but prevents tbe entry of the large hive beetles. The hive beetles found in

Africa are *Holplostonius fuligineus, Diplognatha gagates, Coenochilus bicolor* and *Rhizoplatys trituberculatus* (25). In Madras, *Platyholium alvearium* bas been reported in hives, and *Dermestes vulpinus* in Indo-Cbina (1).

Tbe most serious beetle pest is *Aethina tumida*, reported only from Africa, and commonly known as tbe small hive beetle (25) (26). The adult varies in size but averages about three-sixteentbs of an incb long. In colour they range from brown, brown and black to black. They move about tbe comb very quickly, taking refuge in cells and crevices. The bees cbase them, and try to catch them, but tbey do not seem able to sting them, and are seldom able to get hold of them to carry tliem out of tbe hive. The small hive beetles will breed in any comb not defended by the bees. The eggs are seldom seen, being laid in crevices. The larvae, which are white and may grow to seven-sixteenths of an inch long, feed on pollen and boney. They reduce tbe pollen combs to a pile of dust. The honey they bave soiled ferments, becomes watery and runs out of the combs. Tbe larvae must get down into the soil to pupate, but if tbe bive has been shut up, the larvae will be found in masses on the floor board among the debris from tbe combs.

As it is impossible to stop the small beetles from flying into tbe hives, the only remedies are to ensure that the colonies are strong enough to look after all the combs and to use bives which are as simple as possible. Double-walled hives should be avoided and, as the space between the inner cover and the telescopic roof is a wonderful biding-place, keep the hole in the inner cover open so that the bees can patrol tbat area. Dummy boards also provide extra hiding-places.

Stored comb must be protected carefully. Paradichlorobenzine is a safe and easily handled insecticide. A super-clearer or inner cover is placed on the floor and the crystals of paradicblorobenzine are scattered over it. Tbe boxes of combs are stacked neatly on top of the inner cover and the top of the pile is tigbtly covered. If all cracks between boxes are sealed with scotch tape, the fumes will be kept in and fresh invaders will be kept out. When tbe combs are required for use, the boxes must be put out to air in the shade for two days, so that all traces of paradicblorobenzine are dispelled.

Moths

Among the moths there are also two classes of pest, the robbers and the breeders. Most notable among the robbers is tbe death's-head hawk moth, *Acherontia atropos*, common in Africa, *Acherontia styx* in India, and *Acherontia* sp. in Indo-China (1). Altbough

these moths may be found alive on unguarded comb in weak colonies, strong colonies throw them out in small pieces.

The wax moths, *Galleria mellonella*, the greater wax moth, and *Achroia grisella*, the lesser wax moth, both breed in comb, particularly brood comb. *Galleria* is the more common and does more damage. They both lay their eggs in the combs and the larvae burrow through the wax, feeding particularly on pollen, and weaving tunnels of silk as they go. The larvae of *Galleria* grow to about seven-eighths of an inch long. Before pupating they often chew a depression in the wood of a frame or the hive and then spin a tough cocoon. Unprotected comb is reduced to a mass of webs.

Galleria mellonella appears to be found wherever there are honeybees. *Achroia grisella* is less frequently reported but it is certainly present in Central and South Africa, India, South America, the West Indies and Hawaii.

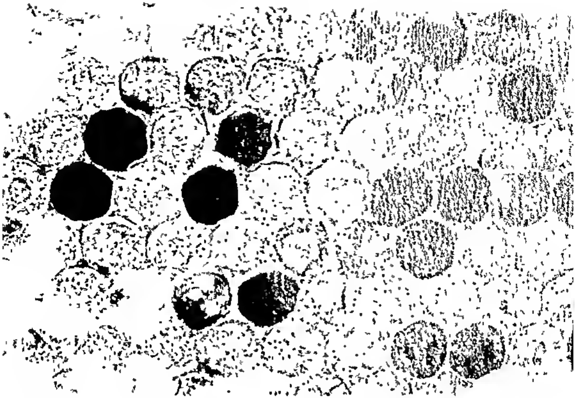
Strong colonies will keep this pest under control and will even clean up combs that are slightly infested. It seems that the bees normally catch the larvae when they first emerge from the egg and before they have a chance to start making their tunnels. A comb removed from a hive will have no trace of tunnels, but if left unprotected for only one day, the beginnings of fine tunnels will be seen.

The use of paradichlorobenzine in stored comb gives protection against the wax moths as well as against the small hive beetle.

Wasps

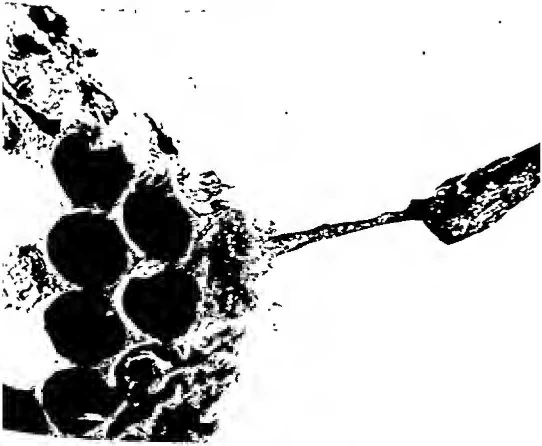
Wasps can be a very serious pest. In South Africa two bee pirate wasps are known, *Palarus latifrons* and *Philanthus diadema* (25). The former certainly is very common in Central Africa. If numerous, this wasp can demoralize a colony to the extent of causing the bees to cease foraging. *Palarus orientalis* is reported in South India. *Palarus* waits around hives during the heat of the day, and pounces on passing foragers, stinging them and carrying them off to its nest as food for its larvae. It seems more prevalent round hives that are in the sun than those in the shade. In South Africa a bowl of water, with a little kerosene in it, placed under the hive entrance has been found effective in trapping these wasps. Apparently there is a 50 per cent chance that the wasp will dive at the bee's reflection and so end up in the bowl. A method found very effective in Tanganyika is for a man to spend an hour or two in the apiary with a small net. He will catch a surprising number of wasps, if he does not bang the hives and annoy the bees. *Philanthus* catches the bees while they are on the flowers foraging.

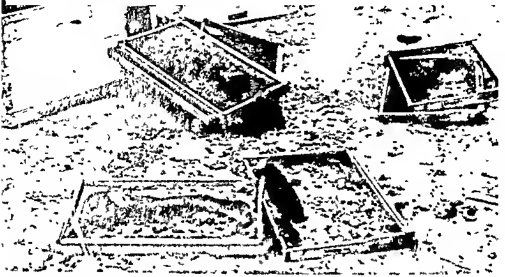
The social wasps and hornets are major pests in the Near East



18. American foul brood. Note the sunken and perforated cappings

9. American foul brood. Decaying larval remains being drawn out with a match-stick to demonstrate 'ropy' condition

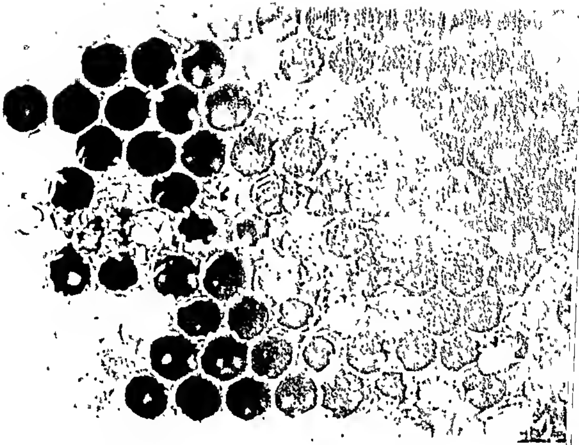




20. Hives after a visit from the honey badger, *Mellivora capensis*

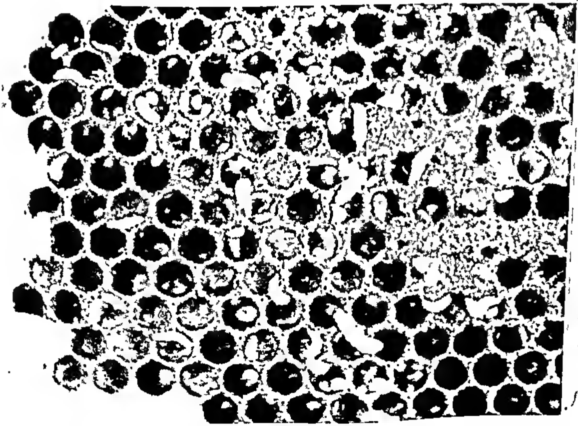
rge hive beetle, *Holplostomus fuligineus*
mall hive beetle, *Aethina tumida* (*right*)
(both ×2)

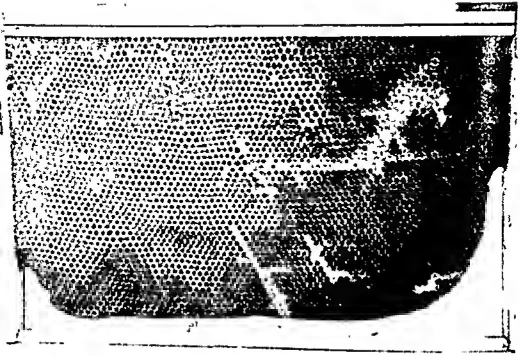
22. Death's-head hawk moth,
Acherontia atropos (×1)



23. Young larvae of the small hive beetle

24. Nearly fully grown larvae of the small hive beetle





25. Greater wax moth, *Galleria mellonella*. Infected comb showing tunnels of silk made by the larvae

26. Bee pirate wasp, *Palarus latifrons* (×2)

27. Queen with several bee lice, *Braula* sp., clinging to her thorax (×2)

The usual treatment for a queen heavily infested is to put her in a matchbox and blow in some tobacco smoke. The *Braula* fall off and the queen can then be returned to her colony.

In addition to the pests mentioned above there are a number of other enemies of bees of less importance. They include viviparous flies which lay larvae on the bees, flies (30) and wasps that lay their eggs in bees, also dragonflies, robber flies, bumble-bees and stingless bees. Mice, squirrels, baboons, bears and even chimpanzees will destroy bee colonies, if they can get at them.

Bee Poisoning

The use of agricultural sprays and dusts to control the pests which attack the farmers' crops is a subject which requires understanding by both the farmer and the beekeeper if the former is not to lose the benefit of pollination and the latter his honey crop. The beekeeper and the farmer should co-operate if the lives of the bees are to be protected.

Honeybees can pick up the poisons in several ways, by contact, in food, either nectar or pollen, and in water. If the bees are flying when the actual spraying or dusting is being carried out, casualties can be heavy. Spraying or dusting when the flowers are in bloom will result in the bees collecting poisoned nectar and pollen. In the case of poisoned nectar, the bees will probably die before they return to the hive and so the poison is not spread. But poison in pollen will be carried back into the hive and will kill the nurse bees and larvae to which it is fed. Poison falling into water from which the bees drink will result in the death of the water collectors. Also, when bees collect the dew off leaves on which the poison has fallen, the collectors will be killed.

Both the farmer and the beekeeper can take precautions which will minimize the danger. Where the farmer hires bees from a migratory beekeeper, he sprays before the flowers are open, and only after spraying is completed does the beekeeper bring his hives to the crop. If further spraying is required after flowering, the hives are removed first.

When bees are sited permanently near the crop which is to be sprayed, the farmer must warn the beekeepers beforehand of the dates of spraying or dusting. The farmer must also ensure that he does not spray when the flowers are open, and be sure that the ground is clear of flowering weeds before spraying.

The beekeeper should shut up his hives the night before spraying is to begin, making sure that the hives are nowhere near where the dust or spray will fall. The hives must be shaded from the sun and have

adequate ventilation to prevent overheating. As the hees must have water even when confined, each hive should be given a feeder containing water, so that the bees will not rush out and collect poisoned dew off the leaves or other poisoned water as soon as they are released.

If these precautions are taken by hoth farmer and heekeeper, mortality will he greatly reduced. The increasing use of selective poisons, poisons which kill the pest that the farmer wants to be rid of hut do not harm bees, is to the mutual benefit of farmer and beekeeper. Toxaphene and methoxychlor have heen shown to he relatively non-toxie to hees. As some agricultural pests are more sensitive than honeyhees to poisons, it is clearly in the farmer's interest to use the minimum strength required to control the pest (31) (32).

Recent researeh by Wiese (33) on the effect of poison on the *adansoni* bee showed that Lindane, Parathion, Malathion, Dieldrin, Aldrin, Systox and DDT were most toxie in order of decreasing toxicity, and Endrin, Chlordane, Schradan and Toxaphene were less toxie when applied as a stomach poison. Testing dusts as contact poisons, he found that Parathion was the most toxic, followed by Malathion, then BHC, DDT and finally Toxaphene which was the least toxie.

REFERENCES

1. SMITH, F. G. (1953). 'Beekeeping in the Tropics.' *Bee World* 34(12): 233–45.
2. JEFFREE, E. P. (1955). 'Acarine disease of the honeybee and temperature.' *Nature* 175: 91.
3. ALBER, M. A. (1956). 'Acarine Disease in Uruguay.' *Bee World* 37(4): 72.
4. SINGH, S. (1957). 'Acarine Disease in the Indian Honeybee.' *Indian Bee J.* 19(3–4): 27–8.
5. MILNE, P. S. (1957). 'Acarine Disease in *Apis indica*.' *Bee World* 38(6): 156.
6. SINGH, S. AND ADLAKHA, R. L. (1958). 'Acarine Disease of Adult Honey-bees.' *Indian Bee J.* 20(6): 64–78.
7. MINISTRY OF AGRICULTURE AND FISHERIES (1949). *Diseases of Bees.* Min. Agric. Bull. No. 100.
8. MINISTRY OF AGRICULTURE AND FISHERIES (1954). *Acarine Disease of Bees.* Min. Agric. Advisory Lft. No. 330.
9. DADE, H. A. (1949). *The Laboratory Diagnosis of Honeybee Diseases.* Quekett Microscopical Club Monograph No. 4.
10. MINISTRY OF AGRICULTURE AND FISHERIES (1952). *The Examination of Bees for Acarine Disease.* Min. Agric. Advisory Lft. No. 362.
11. BAILEY, L. AND CARLISLE, E. (1956). 'Tests with Acaricides on *Acarapis woodi*' (Rennie). *Bee World* 37(5): 85–94.
12. BAILEY, L. (1954). 'The Control of Nosema Disease.' *Bee World* 35(6): 111–13.
13. BAILEY, L. (1955). 'Results of field trials at Rothamsted of control methods for nosema disease.' *Bee World* 36(7): 121–5.
14. BAILEY, L. (1955). 'Control of amoeba disease by the fumigation of combs and by fumagillin.' *Bee World* 36(9): 162–3.
15. MINISTRY OF AGRICULTURE AND FISHERIES (1953). *Foul Brood.* Min. Agric. Advisory Lft. No. 306.
16. ECKERT, J. E. AND BESS, H. A. (1952). *Fundamentals of beekeeping in Hawaii.* Ext. Bull. Univ. Hawaii No. 55.
17. ECKERT, J. E. (1951). 'The development of resistance to A.F.B. in Hawaii.' *Amer. Bee J.* 91(5): 200–1.
18. MICHAEL, A. S. (1954). *American foulbrood of honeybees—how to control it.* U.S. Dept. Agric. Farmers' Bull. No. 2074.
19. CRANE, E. (1954). 'Science and Practice: American and European Foul Brood.' *Bee World* 35(2): 29–30.
20. BAILEY, L. (1957). 'The cause of European Foul Brood.' *Bee World* 38(4): 85–9.
21. SMITH, F. G. (1958). 'Foul Brood in Tropical Africa.' *Bee World* 39(9): 230–2.
22. BURNSIDE, C. E. (1930). *Fungous Diseases of the Honeybee.* U.S. Dep. Agric. Tech. Bull. No. 149.

106

23. WEGNER, A. M. R. (1949). 'A remarkable observation on the Indian honeybee versus the yellow-throated marten from Java.' *Treubia* 20(1): 31–3.

24. FRIEDMANN, H. (1955). *The Honey-guides.* U.S. Nat. Mus. Bull. No. 208.

25. TAYLOR, F. (1939). *Beekeeping for the Beginner.* Un. of S. Afr. Dep. Agric. and For. Bull. No. 199.

26. LUNDIE, A. E. (1940). *The Small Hive Beetle, 'Aethina tumida.'* Un. of S. Afr. Dep. Agric. and For. Sc. Bull. No. 220.

27. MUTTOO, R. N. (1949). *Enemies of Honey Bees in India.* Bhupen Apiaries Pict. Ser. No. 2.

28. RAW, G. R. (1954). 'Science and practice: enemies of bees.' *Bee World* 35(8): 159–60.

29. SKAIFE, S. H. (1921). 'On *Braula coeca* Nietzsch, a dipterous parasite of the honey-bee.' *Trans. Roy. Soc. S. Afr.* 10(1): 41–8.

30. SKAIFE, S. H. (1930). 'Insect Pests of the Hive. I: The Tachinid Parasite.' *Bee World* 11(9): 106–7.

31. COOPER, B. A. (1952). 'A Review of Two Years' Abstracts on Spray Poisoning (1950–51).' *Bee World* 33(6): 90–1.

32. BAILEY, L. (1954). 'Science and Practice: Bee Poisoning.' *Bee World* 35(11): 221–3.

33. WIESE, I. H. (1957). 'The Toxicity of Modern Insecticides to the South African Honeybee.' *S. Afr. Bee J.* 32(2): 7, 9–10; (3): 6–7, 9–10; (4): 5, 7; (5): 9–11; (6): 10–11.

34. BENOIT, P. L. G. (1959). 'The occurrence of the Acarine Mite *Acarapis woodi* in the Honeybee in the Belgian Congo.' *Bee World* 40(6):156.

Chapter VI

BEE FORAGE

Bee Botany—The Scale Hive—Pollen Anolysis—Effects af Climate, Topography and Soil—Vegetotian Types—Lawlond Roin Forest: Equatorial—Lowland Rain Forest: Higher Latitudes of the Tropics—Upland Forest: Equatarial—Upland Forest: Higher Latitudes of the Trapics—Waadland—Wooded Grassland—Grosslonds—Scrub, Bushlond and Thickets—Permanent Swomp—Coastal Plains—Impartant Cultivated Plants: (a) Trees—(b) Fruit Trees—(c) Plantatian Crops—(d) Farm Crops—(e) Weeds—Saurces af Objectionable Haney.

BEE BOTANY

IN addition to obtaining a knowledge of the biology and behaviour of bees, the beekeeper needs to bave a detailed knowledge of the sources of food available to bees in his area. Tbe beekeeper wbo wants to consider management of bees for the production of maximum crops of boney and beeswax must know (*a*) whicb plants are of value to bees, (*b*) wbere they are to be found, (*c*) wben they flower, (*d*) which are merely producers of subsistence for tbe bees, (*e*) wbicb are capable of producing heavy yields of nectar wbicb will enable tbe hees to store surplus food, (*f*) wbicb plants result in the production of high-quality boney, and (*g*) wbich produce unmarketable boney.

As each and every heekeeper's area is different from tbe next, due to the presence of plants in different proportions and variations in local climate, topography, soil and hiotic factors, each beekeeper must study his own local conditions. In some regions of the world, work has heen done on this suhject; the major honey plants are known as well as when they flower. The heekeeper who has this knowledge is fortunate for he can search for a place to put his hees within reach of an abundance of tbe boney plants. However, in the tropics very little research has been done on hee hotany and there is an urgent need to expand this aspect so that heekeeping can he developed in the most suitable areas. In some parts of the world there seems to be a lot of effort wasted in trying to develop heekeeping in areas which appear to be unsuitahle for the production of

profitable crops of honey and wax. It is essential to find those places in which beekeeping can be profitable and to concentrate efforts to develop the industry there. It is pointless spending time and money on more advanced aspects of beekeeping research before a sound knowledge of bee botany and hive management has been acquired.

THE SCALE HIVE

The first step in studying the sources of nectar and pollen is to set up a scale hive. While at a pinch it is possible to use a simple box hive with a capacity of two to three cubic feet, much more will be learnt if a frame hive is used. The queen must have room to expand her brood nest to the utmost of her capacity. One Langstroth box is not big enough for *mellifera* or *adansoni* but it may suffice for *indica*. With *mellifera* or *adansoni* use either an M.D., or give the queen a second Langstroth box as soon as she shows signs of needing it. The importance of giving the queen all the room she wants for breeding is stressed because one cannot learn the capabilities of the bees in the area unless the queen is able to produce the maximum amount of brood with the available food supplies.

Ideally, the hive is set on a counter platform scale. The scale itself is put on a hive stand, with the legs ant-proofed, under shade and shelter from rain, or in a bee house. A spring balance can be used for weighing the hive but it is not so satisfactory, as its use usually involves more disturbance to the bees. The weight of the hive can be read either once daily, at the same time each day, or twice daily, at dawn and at dusk. During a honeyflow the latter provides more information. A note of the weather each day should also be made; useful data are maximum and minimum temperatures, atmospheric humidity, rainfall, and amount of cloud, and in exposed places, information about the wind. The best way of recording the information is on a record card, one card for each month. One side of the card is ruled, one line for each day of the month, with columns for the date, the dawn weight, the dusk weight, weather data, and for remarks about bee activity. On the reverse are recorded the names of all the plants seen in flower within reach of the hive, with a note as to the abundance of each species and whether the bees collect nectar or pollen or both from them.

At the end of one year, a set of completed cards gives a vast amount of information about bee forage and the periodicity of nectar flows. Owing to variations in weather conditions, records are required for at least three years in one place, and five years are even better.

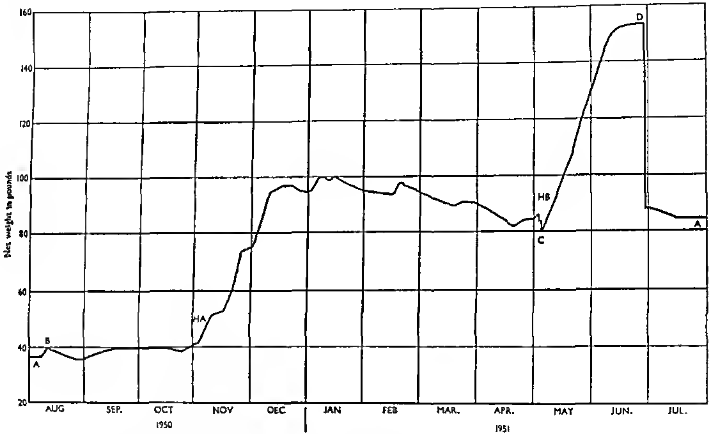


Fig. 12

SCALE HIVE WEIGHTS, AT TALIKWA, TABORA, TANGANYIKA

A, Period of dearth; B, Feeding; HA, First Honeyflow; HB, Second Honeyflow; C, Swarm leaves; D, End of Honeyflow, supers removed.

POLLEN ANALYSIS

While field observations on bees working on different flowers give some information, it is possible to miss important plants, especially if they yield nectar only early in the morning or late in the evening. The most accurate way of determining which plants the bees work on is by pollen analysis.

When bees collect nectar they also obtain a small amount of pollen from the flower. This pollen has either fallen, been blown or been knocked into the nectary or clings to the hairs of the bees. After the nectar has been converted into honey in the hive, some of the pollen remains present in the honey. In addition, bees collect pollen for food and store it in the comb. Clearly, if the pollen which is in the honey and that which is in the combs can be related to the plants of origin, we will then know which plants are of value to the bees. The relative importance will depend upon the quantities of honey containing particular pollen grains, but not on the actual quantities of pollen because the honeys from different plants contain pollen in different proportions.

In order to be able to identify the plants from which pollen has come, it is necessary to build up a collection of named pollen preparations on microscope slides. The pollen grains forming the collections of standards must be collected from correctly identified plants. Thus a major part of this work is the task of collecting pollen samples and herbarium samples from as many plants as possible, having the herbarium specimens named, preparing and mounting the pollen samples and describing each pollen, recording the description in such a manner so that it can be picked out from the whole collection easily. In some countries, work of this nature has already started (1) (2) (3) (4) (5).

The next stage is the collection of honey samples and samples of stored pollen at different seasons, and the identification of the plants of origin. The honey must be taken from pure honeycomb, and must not be the product of honeycomb mixed with pollen combs. About two ounces of honey is required for each sample. Samples of stored pollen must be taken separately, and kept separate. Samples of pollen should be collected weekly, but honey should be taken only when the scale shows an increase in weight. All that is necessary is to scrape a tablespoonful of honey out of one honeycomb. If it is seen from the colour of the comb that there is more than one type of honey, take a separate sample from each.

Each sample of honey or stored pollen must be labelled with the date and locality of collection, the collector's name and address and

the names of the plants wbich have been seen in flower within range of tbe hive. In the laboratory, the pollen grains are separated from the honey by diluting the honey with distilled water and centrifuging it, decanting the honey-water mixture and leaving the pollen grains. After preparation of microscope slides of the pollen material, the grains are identified under the microscope.

EFFECTS OF CLIMATE

Climatic conditions have a decisive effect on botb the vegetation and the foraging instincts of the honeyhees. Bees living in regions which have a long period of dearth when neither pollen nor nectar is availahle, have a strongly developed instinct to gather as much as possible wben it is availahle and to store it to provide food during the period of deartb. In the cold elimates tbe main period of dearth occurs in winter and in the tropics it may occur during a long dry season or during very heavy rains. If they do not forage hard and store well, they die; only those who do store plenty of reserves are able to survive.

In regions where the average winter temperature falls below 57° F. (14° C.) the bees have to form a winter cluster and are eonfined to tbeir hives for long periods, so the foraging instinet is highly developed. Such is the habitat of the bees in Europe and tbe north of India in parts of the Punjab, the Himalayas and parts of Pakistan. It is from bees of this type, mainly from North Italy, tbat the bees used by commercial boney farmers have been developed. And tbese bees transported to the tropics of the New World have maintained their instinct to store, assisted by the action of tbe beekeeper in removing the honey whicb is surplus to the bees' requirements.

However, those bees that have lived for many generations, and probahly evolved, in climates where there is no period of dearth have not needed to develop the storage instinct to any great degree. All they need is enough food in reserve to suffice for a short period of heavy and continuous rain when they cannot fly. Such hees are poor honey producers. Further, if the honeyflow does stop for a period, the hees do not have to go far to ohtain food from other sources, so instead of having to store to survive, they need only migrate.

In the tropics, rainfall has the greatest effect on the growth of vegetation, with the exception of those limited areas along riverhanks, and other places with a high watertahle which enahles a more luxuriant vegetation to flourish. The effect of topography may he important, especially where it impedes drainage or increases the

amount of cloud cover, particularly rouod mountains. Temperature has an influeoce on the efficacy of the rainfall. A high proportion of the rain is lost by evaporatioo, so is not availahle for plant growth. The higher the temperatures the greater is this loss, and the poorer is the vegetation.

Rainfall aod humidity have ao importaot effect oo nectar secretion. In the deciduous woodlands, adequate rainfall in one year results in good crops in the following year. Some species of trees flower on the day following heavy raio. Moist warm conditions with some cloud cover tend to result in good honeyflows, while hot dry winds can he disastrous. Whereas the flowering of many trees varies according to the rains of the previous year, herhs, unable to store much reserves of starch, are responsive to current rainfall.

Edaphic factors also have a bearing on flowering and oectar production. It is well known that different soil types will produce different qualities of honey from the same species. But other factors have not heeo studied. Oo the Ceotral African plateau io Septemher there will he small areas where the trees are all io leaf and flowering when the rest of the trees, of the same species in the same climatic region, are still leafless and may oot come into leaf and flower until Octoher, Novemher or even December. From the look of the topography it seems that it may be coonected with drainage and so possibly soil moisture. In the uplaod grasslands, if a patch is hurned during the dry season, it is a mass of flowering herbs after a few weeks while the oeighhouring unburnt patches have very few herhs in flower.

Another effect, possibly due to low humidity, is that the secretion of nectar by many honey plants, particularly in dry areas, starts in the cool of the evening. It apparently goes on through the night and ceases when the day begins to get hot again. During the heat of the day not so many plants secrete nectar attractive to honeyhees. From 5 p.m. until dark the bees collect nectar in moderate quantities, but at first light in the morning the air is filled with the roar of bees working in flowers. This may continue until 8 a.m.

VEGETATION TYPES

There is a wide variety of vegetation types in tropical regions, ranging from desert to tropical rain forest, and from swamp forest through cool mountain forests to alpine flora on the highest mountains. Only those of most importance to beekeepers will be discussed here.

LOWLAND RAIN FOREST: EQUATORIAL

The equatorial rain forest lies in the lowlands between sea-level and 2,500 to 3,500 ft. according to exposure and latitude. It requires a constant high temperature, an annual mean of 80° F. (27° C.) and a minimum of 65–70° F. (18–21° C.). Rainfall is over 70 in. per annum and the best development occurs in regions of over 120 in. If there is a dry season it is very short, having only three or four months with less than 2 in. of rain. The essential requirement of this type of forest is a high mean annual humidity, about 80 per cent.

The lowland rain forest is a tall dense formation with a large number of species which occur together. Dominants reach a height of 150 ft. or more with a clean bole up to 100 ft. Girths of over 15 ft. are not uncommon. Top-storey trees may be deciduous or semi-deciduous but that does not affect the general evergreen. The canopy is very dense and there are no definite canopy layers. Epiphytes are numerous, particularly ferns, mosses and orchids. Climbers vary greatly in occurrence. Ground vegetation is scanty or absent and grass is absent. Undergrowth is often a tangle of canes, creeping bamboos and palms. The stems of the trees are erect and cylindrical with smooth thin bark. Buttressing occurs with roots on the surface and fluted stems. Leaves are thick and glossy, rarely finely pinnate. Drip tips are typical and when young the leaves are frequently white or pink.

The large variety of species and lack of a definite dry season enable bees to obtain nectar and pollen almost all the year round. The rain forest is inhabited by honeybees in Africa and Asia, but they have not had to develop the storing instinct. Small colonies are able to survive with very little food in reserve. If conditions do become difficult, the colony can migrate and find a better area easily. Where only indigenous bees are used, the crop of a colony is too small for profitable honey farming. For the development of beekeeping in such areas it is necessary to introduce bees with a well-developed storing instinct.

LOWLAND RAIN FOREST: HIGHER LATITUDES OF THE TROPICS

In the more northerly and southerly parts of the tropics, away from the equator, the wet and dry seasons are more marked, the heavy rains occurring when the sun is more or less overhead. The honeyflow is most pronounced during the cooler dry season, and

under these conditions in the New World, the European *A. mellifera* has been most successful. In the Yucatan forests of Mexico (lat. 18°–22° N.) colonies average 300 pounds of honey a year, with very little management, mainly from *Gymnopodium antigonoides* (Polygonaceae), and *Viguieria helianthaides* (Compositae) (6).

UPLAND FOREST: EQUATORIAL

The upland or cloud forest grows on the high mountains of the equatorial tropics. The actual range of elevation depends upon rainfall. It occurs up to 9,000 ft. though in humid areas it may descend to 2,500 ft. Its habitat is subject to prevailing mist and cloud and it grows in regions of medium to high rainfall, upwards from 50 in., with a short dry season. Zones can be distinguished in this forest type and there are transition stages between the Lowland and Upland Rain Forest.

In the lower zone, with a rainfall between 50 and 70 in., Mimosaceous communities occur and it is an important zone for the growing of coffee and bananas. *Eucalyptus* species are often grown and they are an important source of nectar, as also are *Ricinus communis, Croton, Albizzia, Igna, Grevillea, Vernonia* and *Coffea* species. Two separate honeyflows may be obtained in this zone. In Tanganyika it was found that very fine extra light amber honey was obtained from *Eucalyptus* species and *Olea*. Medium amber honey of good flavour had pollen grains in the proportions of 66 per cent from *Coffea arabica* and 33 per cent from *Grevillea robusta*. Dark amber strongly flavoured honeys were found to contain a mixture of *Eucalyptus, Ricinus communis, Croton macrostachys, Triumfetta rhomboidaea* and Compositae (lat. 3° S.) (4).

In the upper zone the forest is more luxuriant, having a rainfall of 70 in. or more. Pyrethrum and tea may be grown in these areas. Excellent boney may be produced, with a fine flavour and extra light amber to white in colour. Pollen analysis showed that the most important species in Kenya in this zone are *Dombeya, Hypericum* and *Olea* (lat. 1° S.) (4).

At higher levels the rainfall decreases and conifers, bamboo and heath appear. In this region the Ericaceous species may be the most valuable to tbe bees.

The upland forest, having a definite period of dearth, and close to the equator, two wet seasons and two dry seasons, requires that the indigenous bees bave a well-developed storing instinct. This is well demonstrated by the bees in Africa and tbe hills of India.

UPLAND FOREST: HIGHER LATITUDES OF THE TROPICS

In the higher latitudes of the tropics, the honeyflow takes place after the rains. At the end of the dry season the trees are often deciduous, but there may be flowers all through the year. It is under such conditions in the mountains of South Mexico (lat. 18° N.) that the largest bee farm in the world, Miel Carlota, flourishes (6) (7) (8).

Some 20,000 colonies of bees, often with a density of ten hives per square mile, average two hundred or more pounds of honey each year from each hive, in return for only four man-hours work per colony. When this enterprise first started the colony average was only thirty-seven pounds of honey, but by breeding only from the best queens and improving management, production was gradually raised to 220 pounds per colony. The main honeyflow is in October, November and December from a Compositae (acahual) and a vine (chayotillo), with a lighter flow during January, February and March (6).

In Cuba (lat. 20°–23° N.) the honey season extends from the middle of September to April or May with the main flows in December, January and February. In the hilly regions the most important honey plants are *Coffea arabica*, *Cordia gerascanthus*, *Calycophyllum candidissimum*, *Cupania* spp., *Gliricidia sepium*, *Matayba apetala*, *Trichilia glabra*, *Sesamum orientale* and *Musa* spp. (6) (9).

In the Brazilian coffee-growing area (lat. 19°–23° S.) the main honeyflow is in July and August, the cool dry season being from April to December. The chief honey plants are *Vernonia polyanthus* (Compositae), during July and August; *Citrus*, August to September; *Coffea arabica*, blooming three or four times during August to November; *Croton floribundus* in November and December, and *Acacia polyphylla* in March. *Eucalyptus* species and *Lippia citriodora* flower more or less through the year. It is noteworthy that among the other honey plants in this area are *Dombeya* spp., other *Vernonia* spp. and *Vitex* spp. (10) (11).

WOODLAND

Variously called tree or bush savannah, dry forest or tree veldt, its main feature is the existence of a very definite dry season. In some parts of the world it may be more correctly called forest, with a closed canopy and no grass, but deciduous in the dry season and having a rainfall usually below 60 in. In the more humid areas of true woodland, about 50 in. of rain, the trees may retain their

leaves throughout tbe dry season, shedding the old ooes aod growing oew ooes almost immediately. But for the main part it is a dry deciduous woodland situated in tropical areas having a rainfall of hetweeo 25 and 50 io. and low humidity. There is a prolonged dry season when the trees lose their leaves and grass fires sweep through the woods. Grass is dominant in the herb layer. The trees are xerophilous, deciduous, 20 to 30 ft. high, occasiooally reaching 60 ft, aod relatively thick-stemmed. The hark is thick and ofteo deeply fissured, giving proteetion agaiost fire. There is geoerally an uodergrowth of scattered shrubs aod tufted grass aod otber herhs. Climbers aod epiphytes are generally absent but may occur io dense patches of woodlaod in the wetter areas. Birds are very oumerous and wild animals abound. Large termite mouods are eommoo and all litter on tbe ground is rapidly consumed hy the termites.

The main suh-type in Africa is the *Brachystegia-Julbernardia* woodlaod, knowo in Tanganyika as Miombo and in tbe Coogo as Mikoodo. Tbe woodlaod extends from south of Lake Vietoria (lat. 3° S.), tbrough Taoganyika, Nyasalaod, Mozamhique, Northern Rhodesia, parts of tbe Belgian Congo and Aogola aod ioto Soutbern Rhodesia. It is mainly oo tbe Central African plateau between 3,000 aod 5,000 feet, but in tbe east aod south of Tanganyika aod in Mozambique it desceods to little more than 1,000 ft. The most dependable hooeyflows occur in the 40 to 50 io. rainfall areas. The 30 to 40 in. areas are excelleot for heekeepiog hut the hooeyflows are less depeodahle. It is in tbis *Brachystegia-Julbernardia* woodlaod that the hulk of Africa's beeswax is produced. It is the product of primitive heekeepiog with simple hives using the indigeoous *adansoni* honeyhee. Average production per colooy is hetween 20 aod 30 pouods of hooey aod 1 to 2 pouods of heeswax.

The hooeyflows vary in periodicity in different parts of the region according to the time of the rains. In the north, the Western Province of Tanganyika, there tends to be a break in the rains in January, but further south the rainy season is more cootiouous.

In western Tanganyika (lat. 3°–8° S., long. 30°–34° E.) the main hooeyflow is from the eod of April uotil the beginning of June from *Julbernardia globiflora* and *Julbernardia paniculata* (Caesalpiniaceae), and may be supplemented by *Leucas* spp. (Labiatae.) Near cultivated areas there may be some Compositae. This period is the tailing off of the main rains. From June to August is the period of dearth, and brood reariog usually stops for a while during July. Although the rains do not start again uotil October or November, the secondary honeyflow may develop in September or October and continue until the end of October or even until the end of Decemher. This secondary

flow is mainly from *Brachystegia* spp. (Caesalpiniaceae) strongly supported by *Lannea* spp. (Anacardiaceae) and *Combretum* spp. Pollen is obtainable from the numerous herbaceous plants from the time the rains develop in November until May, except possibly during a dry period in January. Reproductive swarming takes place during October and early November and again between March and early May. Migratory swarms, caused by the drying up of water supplies or by beekeepers and honey hunters taking all the comb, usually occur in July and August (1) (4).

At lower elevations and drier climates, the woodland tends to become more open and to develop into scrub, bushland and thickets. At higher elevations it develops into wooded grassland and then upland grassland.

At Santa Cruz, Bolivia (lat. 18° S., long. 63° W.), colonies average 178 pounds of honey per hive from wooded areas, the most important source of nectar being *Tipuana tipu* flowering from October to December. Citrus and bananas are among other sources of nectar (12).

WOODED GRASSLAND

Wooded grassland is land covered with grasses and other herbs, generally perennial, with trees and bushes, either evergreen or deciduous, grouped or scattered, with or without thorns, that cover less than 50 per cent of the ground.

Having 25 in. of rainfall or less, the tree species are often *Acacia, Albizzia, Combretum, Terminalia, Euphorbia* and occasional baobabs, *Adansonia digitata*. Although the dry season is very long, bees do well in such areas, obtaining much of their honey from herbs of the Labiatae, Acanthaceae, Compositae, Convolvulaceae, as well as from the *Acacia* trees, some of which flower during the dry season. Where *Dombeya rotundifolia* occurs, it is an important source of very fine extra light amber honey (1) (4).

The upland wooded grasslands, occurring usually above 5,000 ft., produce excellent honey, extra light amber to white, which granulates quickly and finely and has a fine flavour. The trees and shrubs usually include *Protea* spp. and sometimes *Faurea*, both of the Proteaceae, *Dombeya, Erythrina, Bauhinia, Parinari* and *Syzygium*, all of which produce honey. The honey-producing herbs most important in these areas are *Veronia* spp. (Compositae), *Becium* spp. (Labiatae), *Dyschoriste* and *Hypoestes* spp. (Acanthaceae), *Oxygonum atriplicifolium* (Polygonaceae), numerous Compositae and Sapindaceae, Cyperaceae and Liliaceae (1) (4).

GRASSLANDS

In tbe tropical grasslands, the flowering season of the honey-producing herbs is usually short but hees can do well tbere so long as tbey can get water.

In the flood plain grasslands, the main nectar-producing plants are herbs belonging to the families Labiatae, Malvaceae and Compositae flowering towards the end of the rains. In the drier grasslands, sages, *Ocyimum* spp. (Labiatae), may produce a valuable honey crop. This is particularly so in the Rift Valley and Athi Plains of Kenya (lat. 2° N. to 2° S.). The upland grasslands, between 5,000 and 7,000 ft. or more, often intermediate between the woodland at the lower elevation and uplaod forest of the dry evergreen type above, are rich in a profusion of nectar-producing herbs towards the end of the dry season after the grass has been burned off. Tbe main honey plants are the same as tbose in the herb layer of tbe upland wooded grassland.

SCRUB, BUSHLAND AND THICKETS

These types occur wbere there is extreme range of temperature, low rainfall and a prolonged dry season. It is composed of low tborny trees, singly or in thickets, and spiny shrubs. Tbe grass is generally tufted.

In one deciduous thicket type, known as the Itigi Thicket (lat. 6° S., long. 34° E.), the main honeyflow occurs in the middle of tbe rains between January and March from *Combretum trothae*. As it is mainly waterless, tbe bees can live only in tbe few places where man has been able to make waterboles, and as there are no large trees, the bees live underground in disused termite nests.

Most of tbe deciduous bushland includes some taller trees, *Acacia* and *Commiphora* species and in some areas also baobabs. Tbe baobabs, often hollow, are favourite nesting places for bees. Samples of honey from tbese areas contain a great variety of pollen grains, mostly herbs of Labiatae, Acaothaceae, Compositae, Convolvulaceae and trees *Acacia* and *Dombeya rotundifolia* (1) (4).

PERMANENT SWAMP

From the beekeeping point of view the most important type of swamp vegetation is mangrove which occurs in estuaries which are flooded by brackisb water. There are several species of mangrove and their distribution depends upon the salinity of tbe water. *Avicennia nitida* is the principal boney plant on tbe coast in Britisb Guiana

aod Florida (13). In Florida (lat. 25° – 28° N.) mangrove starts flowering in June aod cootinues throughout July. Yields are said to be very sensitive to weather conditions, the bees working the flowers best after rain. Tupelo, *Nyssa ogeche* aod *N. uniflora*, is valuable oo the oortb coast of the Gulf of Mexico and saw palmetto, *Serenoa repens*, in tbe swamps of Florida.

COASTAL PLAINS

Bees do well on the coastal plains in the tropics. On the coast of East Africa and the islaods off the coast (lat. 5°–10° S.) numerous swarms may be found buildiog their nests io the crowns of coconut palms and under the branches of trees for want of any better nesting place. Coconut flowers almost all the year rouod and the bees also work on the cashew nut, *Anacardium occidentale*. Where citrus is grown, this is a valuable source of nectar. Io Cuba, two species of *Ipomoco* and *Rivea corymbosa* (Convolvulaceae), and the royal palm *Roystonco regia*, are the most important honey plants (6). Other useful plants in Cuba are *Gouania polygamo*, *Bouhinio heterophylla*, *Antigonon leptopus*, *Persea gratissima*, *Mangifera indico*, *Mellcocca bijuga*, *Eugenia jambos*, *Viguieria helianthoides*, *Lippio virgato*, *Cordio gerascanthus*, *Pithecolobium arboreum* and *Citrus* (9). At this latitude, 20° to 23° N., the honey season runs from September to May, with the peak during December, January and February. Honey crops of 400 pounds per colony are not uncommon but the average from frame hives is 150 pounds. *Haematoxylon campechianum* is a very important honey plant in Cuba and in British Guiana. In the latter country other valuable sources of honey are *Citrus* spp., *Eucalyptus alba*, and in the upper reaches of the rivers, *Triplaris surinamensis* (lat. 5°–8° N.) (13). The sea grape, *Coccalobo unifera*, is an important honey source io Cuba and it occurs on the coast of Florida, the West Indies aod South America. In Singapore (lat. 1° N.) the main flow is from rambutan, *Nephelium lappaceum*, and durian, *Durio zibethinus*, during April–May and August–September (14). Banana, coconut and other fruits flower throughout the year.

IMPORTANT CULTIVATED PLANTS

(a) Trees

Among the trees of plantation forestry, *Eucalyptus* spp. are the most valuable nectar producers, in the light of present knowledge. In Kenya, *E. paniculata* takes first place followed by *E. saligna*. In Brazil (lat. 22°–24° S.) *E. rabusta*, *citriodora*, *saligna* aod *tereticornis* are valuable. In British Guiana, *E. alba* has an importaot place in

the honey production of that territory (lat. 2°–8° N.). *Eucalyptus* spp. are also useful in the north of India.

An important forest tree growing in the deciduous woodlands of India and which has heen planted in Nigeria is *Dalbergia sissoo* (Papilionaceae). Other *Dalbergia* species are indigenous in Africa and are worked heavily hy the bees hut do not constitute an important source of nectar except in the few areas where they are common.

Useful honey-producing trees grown in plantations and alongside roads are *Cedrela toona*, *Azadirachta indica*, *Tamarindus indica*, *Grevillea robusta*, *Albizzia* spp., royal palm *Roystonea regia*, the horse-radish tree *Moringa oleifera* and the soapnut *Sapindus detergens*.

Mesquite, *Prosopis* sp. (Mimosaceae), otherwise known as algoroba, is a major honey tree in the dry part of America. *P. juliflora* of tropical America and the West Indies has heen introduced into Hawaii where it is one of the most important sources of nectar. *Prosopis* is a useful farm tree in dry regions providing both shade and fodder for stock.

(*b*) *Fruit Trees*

Some of the most important fruit trees grown in the tropics are avocado *Persea gratissima*, mango *Mangifera indica*, *Melicocca bijuga*, rose apple *Eugenia jambos*, Java plum *Eugenia jambolana*, and other *Eugenia* species, including *Eugenia uniflora*, guava *Psidium guyava*, litchi *Nephelium litchi*, durian *Durio zibethinus*, rambutan *Nephelium lappaceum*, banana and plantain *Musa* spp. *Citrus* spp. and *Prunus* spp. (15). It is worth noting that whereas mango yields nectar in many areas, at Tabora in the dry climate of the deciduous woodland region, 35 in. of rain (lat. 5° S., long. 33° E.), the numerous mango trees flower in July at the height of the dry season and do not interest the bees at all, even in the middle of the period of dearth. There may be a secondary flowering in Decemher, and if rain occurs at this time the occasional bee may he seen working the mango just after a heavy storm.

(*c*) *Plantation Crops*

Plantation crops of great value to the bees are coconut *Cocos*, *nucifera*, oil palm *Elaeis guineensis*, sisal *Agave sisalana*, ceara rubher *Manihot glaziovii*, cashew nut *Anacardium accidentale*, and *Coffea arabica*. Oil palm, sisal, ceara rubber and sugar-cane produce unmarketahle honey.

(*d*) *Farm Crops*

There are few tropical agricultural crops in the herbaceous class which are of importance as sources of nectar hut among those which

are useful are sunflower *Helianthus annuus*, sesame or sim-sim *Sesamum indicum* or *S. orientale*, Indian mustard *Brassica juncea*, and *Brassica campestris* (16). Cotton, *Gossypium* spp., is very variable in its value as a honey plant. It appears that on black heavy soils it yields well, the honey being light and of a mild pleasing flavour, particularly during warm and wet weather. On sandy soils, and in dry weather, the crop is dark and strong in taste, and sometimes honeydew is produced.

(*e*) *Weeds*

The weeds of cultivation and pioneering plants of secondary growth are often major sources of nectar. The various *Vernonia* species, (Compositae), of the upland areas of South America and Africa are most important. Others are *Ipomoea* spp. (Convolvulaceae), *Hibiscus* and others of the Malvaceae; *Oxygonum atriplicifolium* and *Antigonon leptopus* of the Polygonaceae; *Bidens pilosa* and other *Bidens* spp., *Tridax procumbens* and *Viguieria helianthoides* of the Compositae; *Triumfetta* spp. (Tiliaceae); *Richardia scabra* and *Borreria* spp. of the Rubiaceae; *Stylosanthes bojeri* (Papilionaceae); *Waltheria indica* = *americana* of the Sterculiaceae; *Leucas*, *Leonotis* and *Ocimum* spp. of the Labiatae (4).

SOURCES OF OBJECTIONABLE HONEY

Elaeis guineensis, the red palm-oil tree, produces dark amber, strongly flavoured honey. Sisal, *Agave sisalana*, yields abundant quantities of very pale honey of unpleasant taste. As the nectaries are a long way from the anthers, the bees collect very little pollen in sisal honey and this may make it difficult to identify. *Manihot glaziovii*, a Euphorbia which used to be grown for rubber, produces unpalatable honey. The honey from castor-oil plant, *Ricinus communis*, another Euphorbia, is dark amber and strongly flavoured. Sugar-cane, *Saccharum officinarum*, is grown extensively in the hot humid regions of the tropics and is the source of large quantities of unmarketable honeydew. The cajeput tree, *Melaleuca leucodendron*, introduced into Florida from Australia and found in Malaya, is another source of unpalatable nectar.

REFERENCES

1. SMITH, F. G. (1956). *Bee Batany in Tanganyika*. Aberdeen University D.Sc. Thesis, 2 vols.
2. DEANS, A. S. C. (1953). *The pollen analysis of honey*. Central Assoc. B.B.K.A. Lecture.
3. SEN, J. AND BANERJEE, D. (1956). 'A Pollen Analysis of Indian Honey.' *Bee World* 37(3): 52–4.
4. SMITH, F. G. (1957). 'Bee botany in East Africa.' *E. Afr. Agric. J.* 23(2): 119–26.
5. DEANS, A. S. C., (1957). *Survey af British Honey Sources*. Bee Research Assoc. Report. BRA, 142.
6. CRANE, E. (1957). 'Second American bee journey: II. States of the south and west.' *Bee Warld* 38(10): 249–57; 'III. Cuba and Mexico.' *Bee World* 38(12): 301–13.
7. WILLSON, R. B. (1953). 'Beekeeping in Mexico.' *Glean. Bee Cult.* 81: 79–82, 143–6.
8. WILLSON, R. B. (1955). 'Meet the champions: Miel Carlota.' *Glean. Bee Cult.* 83: 329–32, 408–10, 447, 473–6, 509.
9. ORDETX, G. S. (1956). 'Beekeeping in Cuba.' *Amer. Bee J.* 96(1): 27–8; (1957) *Glean. Bee Cult.* 85(3): 168–71.
10. AMARAL, E. (1957). 'Honey bee activities and honey plants in Brazil.' *Amer. Bee J.* 97(10): 394–5.
11. MUNRO, J. A. (1954). 'Sidelights of beekeeping in Brazil.' *Amer. Bee J.* 94(10): 380–2.
12. MUNRO, J. A. (1953). 'Beekeeping in Bolivia.' *Glean. Bee Cult.* 81(4): 204–8, 253.
13. CARR, A. F. (1953). 'Observations on beekeeping in British Guiana.' *Report of the State Apiarist, Iowa*, 1953: 73–4.
14. KIAT, L. C. (1954). 'Beekeeping in Singapore.' *Glean. Bee Cult.* 82(11): 649–50, 657.
15. MUTTOO, R. N. (1956). 'Facts about beekeeping in India.' *Bee World* 37(7): 125–33.
16. KAPIL, R. P. (1957). 'The length of life and the brood-rearing cycle of the India bee.' *Bee Warld* 38(10): 258–63.

Chapter VII

BEEKEEPING METHODS AND ECONOMICS

Honey Hunting—Primitive Beekeeping—Frame Hive Beekeeping—The Hobbyist and Sideline Beekeeper—The Commercial Beekeeper—Size of a Bee Farm—Financial Aspects—Primitive Hive Beekeeping—Frame Hive Beekeeping, Part Time—Commercial Beekeeping—300-hive Bee Farm—500-hive Bee Farm.

IN its most primitive form the exploitation of the honeybee is carried out by honey hunters who seek wild colonies for the honey and wax. The first step forward is the making of simple hives baited with beeswax to attract swarms, and in due season these too are robbed of their comb. The second step is the use of simple hives with some form of management so that the life of the colony in the hive may continue. The third step is the management of simple hives in an attempt to increase the crop as well as to perpetuate the colony; this was the stage reached by the most advanced of the skep-hive beekeepers in Europe towards the end of the nineteenth century. The fourth step is the use of movable frames within the hive so that more intensive management can be practised, the bees can be closely studied and disease controlled. This leads to more specialized forms of beekeeping such as queen breeding and royal jelly production.

HONEY HUNTING

Searching for wild colonies of bees living in hollow trees and caves, often with the assistance of honey-guide birds, is still widely practised by the forest dwellers in Africa and tropical Asia. In Asia it is the only method of collecting the crop from the unmanageable *Apis dorsata*. Almost invariably the bee colony is destroyed and it is extremely wasteful of bees. Also, much time which could otherwise be spent in collecting the crop from hives is wasted in searching for nests. The honey hunter spends very little time actually working on nests; most of his time is spent looking for colonies, cutting down large trees or burrowing under rocks.

The honey hunter places no value on his time, requires no equipment other than an axe and a container to hold the comb. Often

working in a party of three or four for mutual protection against wild animals, the honey hunters may collect the crop from four wild colonies in one day, obtaining perhaps 120 pounds of honey and eight pounds of wax, or about thirty pounds of honey and two pounds of wax per head. Owing to the limitations of the distance the honey hunter can travel and the availability of wild colonies, it is not many days before he has exhausted all the possibilities in his part of the country.

PRIMITIVE BEEKEEPING

Primitive beekeeping involves the construction of suitable containers for the bee colonies to occupy. The containers may be made of straw like the European skeps, hollowed logs, the bark of trees, mud pipes, bamboo and reeds, banana leaves or sawn timber. The containers give the bees protection against the heat of the sun and the entry of rain, and are put in places where the bees will not be troubled by ants, are out of reach of grass fires and safe from the attacks of pests such as the honey badger.

Usually the hives are made large enough to contain the bees and all the comb they might build in a good year, a capacity of two to three cubic feet being considered adequate. The hives are baited by smearing the insides with hot beeswax, propolis or Meliponidae wax to give them a smell which will attract the attention of swarms. When the hives are constructed, provision is made for the entry and exit of the bees by making holes in the end or bottom of the hive. Some sort of door is made to enable the beekeeper to collect the comb, but the more primitive types are made of a hollowed-out log split lengthways down the middle and the two halves have to be separated when the crop is collected. More advanced types are made so that the beekeeper can take out the honeycomb without destroying the brood nest.

The capital outlay for this type of beekeeping is very small. Often the beekeepers make their own hives but even if they buy them they do not cost much. A little equipment is required to deal with the preparation of the honey and beeswax, but normally it is composed of common domestic utensils. Other than making and siting hives, the beekeeper does nothing else except collect, prepare and market the crop. In the more important beekeeping areas of Africa, beekeepers frequently own 200 primitive hives and a few have as many as 1,000, but it is a very good year if 75 per cent of the hives are occupied by bees. More often than not, only about one-third have bees in them.

Chapter VII

BEEKEEPING METHODS AND ECONOMICS

Honey Hunting—Primitive Beekeeping—Frame Hive Beekeeping—The Hobbyist and Sideline Beekeeper—The Commercial Beekeeper—Size af a Bee Farm—Financial Aspects—Primitive Hive Beekeeping—Frame Hive Beekeeping, Part Time—Commercial Beekeeping—300-hive Bee Farm—500-hive Bee Farm.

IN its most primitive form the exploitation of the honeybee is carried out by honey hunters who seek wild colonies for the honey and wax. The first step forward is the making of simple hives baited with beeswax to attract swarms, and in due season these too are robbed of their comb. The second step is the use of simple hives with some form of management so that the life of the colony in the hive may continue. The third step is the management of simple hives in an attempt to increase the crop as well as to perpetuate the colony; this was the stage reached by the most advanced of the skep-hive beekeepers in Europe towards the end of the nineteenth century. The fourth step is the use of movable frames within the hive so that more intensive management can be practised, the bees can be closely studied and disease controlled. This leads to more specialized forms of beekeeping such as queen breeding and royal jelly production.

HONEY HUNTING

Searching for wild colonies of bees living in hollow trees and caves, often with the assistance of honey-guide birds, is still widely practised by the forest dwellers in Africa and tropical Asia. In Asia it is the only method of collecting the crop from the unmanageable *Apis dorsata*. Almost invariably the bee colony is destroyed and it is extremely wasteful of bees. Also, much time which could otherwise be spent in collecting the crop from hives is wasted in searching for nests. The honey hunter spends very little time actually working on nests; most of his time is spent looking for colonies, cutting down large trees or burrowing under rocks.

The honey hunter places no value on his time, requires no equipment other than an axe and a container to hold the comb. Often

working in a party of three or four for mutual protection against wild animals, the honey bunters may collect the crop from four wild colonics in one day, obtaining perhaps 120 pounds of honey and eight pounds of wax, or about thirty pounds of honey and two pounds of wax per head. Owing to the limitations of the distance the honey hunter can travel and the availability of wild colonies, it is not many days before he has exhausted all the possibilitics in his part of tbe country.

PRIMITIVE BEEKEEPING

Primitive beekeeping involves the construction of suitable containers for the bee colonies to occupy. The containers may be made of straw like the European skeps, hollowed logs, the bark of trees, mud pipes, bamboo nnd reeds, banana leaves or sawn timber. The containers give the bees protection against the heat of tbe sun and the entry of rain, and are put in places where the bees will not be troubled by ants, are out of reach of grass fires and safe from the attacks of pests such ns the honey badger.

Usually tbe hives are made large enough to contain the bees and all the comb tbey might build in a good year, a capacity of two to three cubic feet being considered adequate. The hives nre baited by smearing tbe insides with hot beeswax, propolis or Meliponidae wax to give tbem a smell which will attract the attention of swarms. When tbe hives are constructed, provision is made for the entry and exit of tbe bees by making holes in the end or bottom of the hive. Some sort of door is made to enable the beekeeper to collect the comb, but the more primitive types are made of a hollowed-out log split lengthways down the middle and the two halves have to be separated wben the crop is collected. More advanced types are made so that the beekeeper can take out the honeycomb without destroying the brood nest.

The capital outlay for this type of heekeeping is very small. Often the beekeepers make their own hives hut even if they buy them they do not cost much. A little equipment is required to deal with the preparation of the honey and heeswax, but normally it is composed of common domestic utensils. Other than making and siting bives, the beekeeper does nothing else except collect, prepare and market the crop. In the more important heekeeping areas of Africa, beekeepers frequently own 200 primitive hives and a few have as many as 1,000, but it is a very good year if 75 per cent of tbe hives are occupied by bees. More often than not, only about one-third have bees in them.

In Africa, a hive which has been occupied by a swarm tbat year may produce about fifteen pounds of hooey and ooe pouod of wax, but those beekeepers wbo bave their hives oear permaoent water and preserve the colony from year to year average thirty pounds of hooey aod two pounds of wax from the occupied hives.

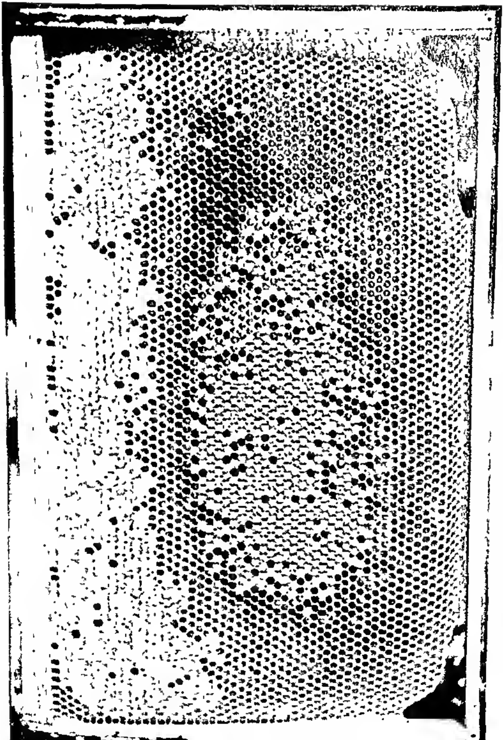
The use of simple hives on the advaoced-skep principle and keepiog hives io total shade cao increase the yield to twice the amount of honey and wax obtained from the more primitive unmaoageable hives.

FRAME HIVE BEEKEEPING

Frame hives are fitted with movable frames in whicb the bees are persuaded to build tbeir combs. They are usually composed of several boxes, one on top of the other. The lower box, or in some cases two boxes, is used for holding the brood nest, aod the upper for collectiog the crop. Tbe several boxes containiog movable frames eoable tbe beekeeper to manage his hive to produce the maximum amouot of honey and beeswax. Frame hives can be moved about aod the beekeeper can take his bives to wherever tbe bees can collect nectar. They are expensive and to justify the heavy capital outlay they must be capable of producing a far better return than primitive bives. Frame bives will produce bigger returns only if they are stocked witb good strains of honeybee aod intelligently managed by the beekeeper, aod that requires a lot of knowledge.

THE HOBBYIST AND SIDELINE BEEKEEPER

Some beekeepers keep bees for a hobby or as a sideline to some other occupation, for they make a fascinating study as well as being productive. The beekeeper who is really ioterested in studying bees and watching their development will use frame hives, for it is only in them that he is able to examine the combs. The mao who makes beekeeping a hobby does not mind investing money in such expensive hives; he is repaid by the ability to examine bis bees closely. It is such people wbo have made tbe greatest contributions to our knowledge of bees, aod so made commercial beekeeping possible. The sideline beekeeper bas developed from being a hobbyist, and baving learnt how to manage bees and obtain a profitable crop from them, bas expaoded tbe number of his bives with a view to supplementing his income from the profits of beekeeping. He will theo have started to develop the approach of the commercial beekeeper.



II. Bee collecting pollen on pyrethrum

III. Bee house, showing the arrangement of identifying colours round the hive entrances

THE COMMERCIAL BEEKEEPER

The commercial beekeeper must make a living out of his bees. Of necessity he will confine himself to the bare essentials and he cannot afford to indulge in extravagances in equipment or management. This is the basic cause of the different viewpoints of hobbyist and commercial beekeepers in Europe. If the hobbyist or the research worker is to help in the development of the industry it is imperative that he should keep in mind the requirements of the commercial beekeeper, and that he does not lead himself astray with excessive enthusiasm for expensive and complicated gadgets.

No one who has the money to invest can buy hives, stock them with bees and then expect to make a profit unless he has a sound background of experience. All successful bee farms have been built up slowly, the beekeeper starting with bees as a hobby, developing into a sideline, and as he learnt more and more, expanding within the limits he can manage efficiently and profitably.

SIZE OF A BEE FARM

Presuming unlimited capital, the number of colonies one expert beekeeper can manage, with or without the assistance of unskilled labour, depends upon the amount of management that has to be carried out on each hive. The more intensively the hives are managed, the bigger the crops which will be obtained per hive, but on the other hand, the smaller the number of hives which can be dealt with. The beekeeper with few hives can spend more time working on each hive and by doing so he may get a high average crop. As he expands he can spend less time on each hive, but with the knowledge he has obtained he will simplify management so that it is more efficient and he will have improved his strain of bees so that he is still getting as good an average crop as before, or even better. But there comes a limit when the decrease in the amount of management per hive begins to result in a decrease in the crop per hive, though it may still pay to expand, obtaining a greater overall crop but at a lower average per hive.

Some of the most experienced and successful bee farmers consider that one man can manage between two and three hundred hives on intensive systems of management, and an expert beekeeper with two unskilled assistants can manage five hundred hives intensively. On the other hand, if less intensive methods were practised, these figures could be doubled.

A word about unskilled assistants would not be out of place here.

The assistants work *with* the beekeeper, not on their own. The beekeeper himself must inspect the hives, decide what is to be done and do it himself. The assistants help by smoking the hives, taking off lids and putting them on again, carrying away boxes and bringing fresh ones. The beekeeper and his assistants work as a team. I mention this because there is a tendency in some tropical countries for the expert to stand back and supervise while the unskilled assistants do the work. In beekeeping, that is doomed to inefficiency and failure. An assistant can be trained to become expert in some specialized branch of the work such as assembling hives, packing honey or even grafting queen cells. In time, an assistant with the aptitude may himself become expert and be able to take charge of a team.

An interesting example of the development of an extensive bee farm under tropical conditions is to be seen in South Mexico. This commercial enterprise, Miel Carlota, is run by two partners and they employ 150 people, mostly illiterate. They run 20,000 honey-producing colonies, averaging some 200 pounds of honey per hive, as well as producing 30,000 queens per year, producing royal jelly, and turning out 200 complete frame hives each day from their workshop. When they started, the partners were complete amateurs, beginning with seven hives which produced an average of only 37 pounds of honey in the first year. There was no one to teach them and there were no books applying to their conditions. They learnt from experience and gradually developed, increasing the average crop per hive as they did so.

FINANCIAL ASPECTS*

Bee farming can be a profitable undertaking; one has only to look at the numerous bee farms in America including the tropical parts, Australia, New Zealand as well as those in Britain and South Africa, for examples. Bee farming requires three things, capital, knowledge and aptitude. One or two of them are no use without the third. A mistake to guard against is expending all the capital in the effort to obtain knowledge.

Usually a commercial bee farm develops in the first place from a few hives which are kept as a hobby. A beekeeper who depends for his livelihood on some other occupation can run part-time apiaries which he can develop to a high degree of efficiency and considerable size. In doing so he is obtaining knowledge, and any mistakes made

* The currency used in the calculations which follow is the East African shilling (Shs.), which is equal in value to the shilling of Britain, Rhodesia and South Africa. Shs. 20 = £1; approximately Shs. 7 = U.S. $1.

in the early stages are not fatal to the enterprise. The difficulty comes when the intending hee farmer has reached the stage when he has all the hives he can manage in his spare time and to expand further necessitates giving up the joh on which his livelihood depended. He should hy this time have a sound knowledge of hee farming and what sort of living he himself can make from it. If he has sufficient capital to make the increase to a full-size one-man outfit, and tide him over a couple of lean years, then he can take the step.

Another method of obtaining knowledge is to work for a year or two on a successful modern hee farm, or, better still, work for a year on each of two hee farms worked on different systems, or under different climatic conditions. In addition to ohtaining knowledge and proving to oneself that one has the aptitude to he a commercial heekeeper, it is necessary to consider the financial side.

Most hooks on heekeeping avoid discussing the financial aspects and it is certainly fraught with dangers. First, the value of money is constantly changing; secondly, the cost of hives and equipment varies in different countries, the price ohtainahle for honey depends on how near the producer is to his consumer markets, and the standard of living of different people varies enormously.

The costs that are used here are those ruling now in the heart of Tanganyika where there is no firm making hives or equipment and everything has to he imported from Britain. The population is small and markets are hundreds of miles away, so the price of honey is not inflated. The main value of the costings is that it will give the reader some idea what factors he has to consider when applying them to the conditions in the part of the world where he lives.

The price given for honey is that ruling for filtered high-grade honey at railhead, packed in proper honey tins protected hy corrugated cardboard cartons.

PRIMITIVE HIVE BEEKEEPING

First of all we will consider tbe case of the beekeeper who cannot afford to buy frame hives, and does not know how to use them. Instead he decides to use box hives or the skep system of management and keeps them in a hee house. He uses a boney press to separate the honey from the wax and he bas a two-hundredweight honey tank with a simple filter.

Our beekeeper has built up gradually, stocking his hives with swarms. Now he has two hundred hives. His hives and his bee houses he has built himself hut they must be valued at what it would cost if he had had to pay someone else for the labour and materials.

He has ten small bee houses each with twenty hives producing an average of thirty pounds of honey and two pounds of wax per hive. When he first hived his swarms he fed each with ten pounds of sugar.

Expenditure	*Shs.*
10 bee houses at Shs. 200	2,000
200 hives at Shs. 10	2,000
1 honey press	360
1 honey tank with filter	150
1 bee veil	22
1 bee smoker	20
2,000 lb. of sugar at –/60	1,200
Total	5,752

Gross revenue—from hives when fully stocked	*Shs.*
6,000 lb. of honey at Shs. 1	6,000
400 lb. of beeswax at Shs. 3	1,200
Total	7,200

From his revenue he will have to deduct his expenses which are mainly empty tins and cloth for straining his honey and beeswax. If he lives away from railhead, he will have to pay for the transport of his empty tins and the carriage of the full ones. If he lives 100 miles from railhead, transport will come to Shs. 4 per tin. To make the accounts more accurate he should allow for the depreciation of his bee houses at the rate of 20 per cent as they are only temporary structures. The depreciation on hives and equipment should be allowed at 10 per cent.

Expenses	*Shs.*
108 4-gallon honey tins at Shs. 3/60	390
Sundries, straining cloth, etc.	14
Transport on 108 tins for 100 miles	432
Total	836
Depreciation	
Bee houses, Shs. 2,000 at 20 per cent: Shs. 400	
Hives and equipment Shs. 2,552 at 10 per cent: Shs. 255	655
Total expenses	1,491
Surplus	5,709

This Shs. 5,709 is in addition to the Shs. 655 put on one side for depreciation, to he used for replacing bee houses and equipment as needed. Now, if the heekeeper was employed as an artisan, a motor-driver or a carpenter, he would earn Shs. 1,200 to Shs. 1,800 a year. His earnings as a heekeeper after all his hives are fully stocked are more than Shs. 4,000 more than he needs to support himself and his family in a reasonahle manner. This he can use for huilding better hee houses of more permanent materials, buying some frame hives to experiment with and put some money on one side towards a truck of his own.

FRAME HIVE BEEKEEPING, PART TIME

The heekeeper who wishes to use frame hives must either make them himself or pay quite a lot for them. A frame hive complete with supers, queen excluder, frames, foundation, nails and the other bits and pieces, if hought in the flat, costs Shs. 250 in England at retail prices. The heekeeper who wants to huy 20 hives will most probahly get wholesale discount for quantity, hut even so, hy the time he has paid sea freight, insurance, railage and transport, they will still cost him at least Shs. 250 each. So that will he Shs. 5,000 for hives alone. A good hee house made of permanent materials to hold 20 hives costs about Shs. 2,000 to huild, plus another Shs. 300 for hive stands. In addition he will want some honey-extracting equipment, which will he kept to the bare essentials; a hand-operated centrifugal honey extractor, Shs. 300; and a two-hundredweight honey tank with filter, Shs. 150. Also there will he sundries such as smoker, hive tool, uncapping knife and paint. The hives will he stocked with swarms which the beekeeper himself catches, and they will he each fed with ahout twenty pounds of sugar to get them estahlished.

Capital	*Shs.*
20 hives complete with supers, frames, etc.	5,000
1 hee house in permanent materials	2,000
Hive stands	300
1 honey extractor	300
1 honey tank, 2 cwt.	150
1 smoker	20
1 hive tool	12
1 uncapping knife	18
Sundries	100
400 lb. of sugar at –/60	240
Total capital	8,140

As a part-time heekeeper, he will work on the hives in his spare time, store his spare equipment in an outhouse aod do the extractioo io the kitcheo. He lives near his market and his only expenses are oo hooey jars and lahels. The whole of his crop he retails himself at Shs. 3 per pouod. Let us see how this works out with crops of 30, 60 and 120 pouods of hooey and 1, 2 aod 4 pouods of heeswax per hive.

Receipts (Wheo hives productive)	*Crop* 600 *lb.* (30 lb. per hive)	*Crop* 1,200 *lb.* (60 lb. per hive)	*Crop* 2,400 *lb.* (120 lh. per hive)
	Shs.	Shs.	Shs.
Hooey at Shs. 3 per lb.	1,800	3,600	7,200
Beeswax at Shs. 3 per lb.	60	120	240
Total	1,860	3,720	7,440
Expenses			
Bottles at –/80 each	480	960	1,920
Labels	20	40	80
	500	1,000	2,000
Depreciation on bee house, hives and equipmeot at 10 per cent	790	790	790
Total	1,290	1,790	2,790
Surplus	570	1,930	4,650
Surplus as a perceotage of capital	7%	23·7%	57%

From this it is clear tbat if crops of ooly thirty pounds of honey per hive are obtaioed, frame bive heekeepiog, eveo as a sideline, is hardly worth while. If he bad invested his capital he could expect 5 or 6 per cent interest, and if he had horrowed it he would have to pay 8 per ceot interest. To justify their use, hees io frame hives have got to be made to produce at least sixty pounds of honey per hive, if the beekeeper is so fortunate as to live near a retail market.

Let us suppose that the sideline heekeeper with 20 frame hives lives 100 miles from his selling point and has to sell his hooey in bulk. The price he gets is Shs. 1/16 per pound for the hooey packed io 56-pound honey tins protected hy corrugated cardboard cartons.

Receipts	*Crop 600 lb.* (30 lb. per hive) Shs.	*Crop 1,200 lb.* (60 lb. per hive) Shs.	*Crop 2,400 lb.* (120 lb. per hive) Shs.
Honey at 1/16 per lb.	696	1,392	2,784
Beeswax at 3/– per lb.	60	120	240
Total	756	1,512	3,024

Expenses	*12 tins*	*22 tins*	*43 tins*
Tins, 56 lb. at 3/60	43/20	79/20	154/43
Cartons at 1/70	20/40	37/40	73/10
Transport at 4/–	48/00	88/00	172/00
Depreciation at 10%	790/00	790/00	790/00
Total	901/60	994/60	1,189/53
Sbortfall	145/60	Surplus 517/40	1,834/47
Surplus as a percentage of capital		5·1%	22·6%

So we see that an average of thirty pounds of honey per hive would result in a loss. Even a sixty-pound crop only brings in as much as if the money had been invested in safe stocks, or not enougb to pay the interest on the capital had it been borrowed. Only a crop averaging 120 pounds of honey per hive would pay.

Thus a beekeeper living well away from his markets and having to sell in bulk would have to be able to produce an annual average crop of 120 pounds of honey per hive to justify the heavy capital outlay on frame hives. If he could not do this, then he could not consider expanding his enterprise.

COMMERCIAL BEEKEEPING

We will now consider the case of an experienced beekeeper who has found a good area for beekeeping and is able to average 120 pounds of honey per hive per year. We will assume that he has obtained his experience working on a bee farm and he has the capital to invest in the equipment for 200 colonies in bee houses. He has bought a pick-up for carrying supers and gear between his base and the bee houses. He has also built a honey house and store. A year later he has been fortunate enough to have all hives in production.

Capital	*Shs.*
200 hives, complete at 250/–	50,000
5 bee houses to hold 40 hives each at 4,000/–	20,000
Hive stands	3,000
Honey house and store	10,000
1 extractor, large size, hand-operated	600
4 honey tanks, 2 cwt., at 150/–	600
1 steam-heated uncapping knife and boiler	100
1 uncapping tray	100
Sundries, including tools and paint	1,200
1 pick-up, 12 cwt.	14,000
4,000 lb. of sugar for establishing colonies	2,400
Total capital	102,000

In addition to the capital used above, he must have enough additional capital to maintain himself and his family, run the pick-up and buy containers for the year's crop. He is working on his own without any paid help. We will consider his position according to average crops of 90, 120 and 150 pounds of honey per hive.

Receipts	*90 lb. p. h.*	*120 lb. p. h.*	*150 lb. p. h.*
(When all hives are productive)	18,000 *lb.*	24,000 *lb.*	30,000 *lb.*
Honey at 1/16 per lb.	20,880	26,840	34,800
Beeswax at 3/– per lb.	1,800	2,400	3,000
Gross receipts	22,680	29,240	37,800
Expenses			
Cost of running pick-up, fuel, oil, upkeep	4,000	4,000	4,000
Transport of honey 100 miles at 4/– per tin of 56 lb.	1,288	1,712	2,144
Tins, 56 lb. at 3/60	1,160	1,540	1,930
Cartons at 1/70	548	728	912
Depreciation at 5% on hives, buildings and equipment	4,280	4,280	4,280
Depreciation at 10% on pick-up	1,400	1,400	1,400
Miscellaneous expenses	4,000	4,000	4,000
Total expenses	16,676	17,660	18,666
Surplus	6,004	11,580	19,134
Surplus as percentage of capital	5·9%	11·3%	18·7%

So, with a 200-hive bee farm, the beekeeper must still average at least 120 pounds of honey per hive per annum to make even a modest profit.

300-HIVE BEE FARM

Supposing the beekeeper set himself up with 300 hives and the bee houses to contain them, and employs one man to help him.

Capital		*Shs.*
300 hives at 250/–		75,000
7 bee houses		30,000
Hive stands		4,500
Honey house		10,000
1 extractor		600
4 honey tanks		600
Sundries		1,400
Pick-up, 12 cwt.		14,000
6,000 lb. of sugar		3,600
	Total capital	139,700
Receipts (when all hives are productive)		*Shs.*
Honey, 120 lb. per hive, at 1/16 per lb.		41,760
Beeswax, 4 lb. per hive, at 3/– per lb.		3,600
	Total receipts	45,360
Expenses		*Shs.*
Cost of running pick-up		5,000
Transport of honey		2,572
643 tins, 56 lb. at 3/60		2,315
643 cartons at 1/70		1,093
Depreciation at 5 per cent on hives, buildings, etc.		6,105
Depreciation at 10 per cent on pick-up		1,400
Wages at 100/– per month		1,200
Miscellaneous expenses		4,000
	Total expenses	23,685
	Surplus	21,675
Surplus as percentage of capital		15·5%

500-HIVE BEE FARM

If the beekeeper sets up with 500 hives, he will need two unskilled assistants to help him.

Capital	*Shs.*
500 hives at 250/–	125,000
10 bee houses	50,000
Hive stands	7,500
Honey house and store	10,000
1 extractor, power driven	1,200
6 honey tanks	900
Sundries	1,400
Lorry, 3-ton	18,000
10,000 lb. sugar	6,000
Total capital	220,000
	(£11,000)

Receipts (Average crop per hive 120 lb. honey)	*Shs.*
Honey, 60,000 lb. at 1/16	69,600
Beeswax, 2,000 lb. at 3/–	6,000
Total receipts	75,600
	(£3,780)

Expenses	*Shs.*
Cost of running lorry	6,000
1,072 honey tins, 56 lb. at 3/60	3,860
1,072 cartons at 1/70	1,822
Transport of honey	4,288
Depreciation, Shs. 196,000 at 5 per cent	9,800
Depreciation, Shs. 18,000 at 10 per cent	1,800
Wages, 2 men each at 100/– p.m.	2,400
Miscellaneous expenses	4,000
Total expenses	33,970
	(£1,698)

Surplus Shs. 41,630 (£2,081) = 18·9 per cent

It can be seen that honey farming with frame hives, under the conditions at present prevailing in the middle of Africa, can be made to pay only if an annual average honey crop of 120 pounds per hive or more can be assured. If the price obtainable for honey was increased, the profits would be greatly enhanced. Similarly, if crops of more than 120 pounds per hive can be obtained, the position is improved. It will be noticed that in every case the cost of bee houses has been included. The use of bee houses is essential in tropical Africa, to provide protection for the hives and to make management of frame hives possible.

The reader should substitute the prices and costs prevailing in his own country in place of the figures given here in order to obtain an estimate of the possibilities of frame hive beekeeping as a business in his area.

It is considered that the greatest number of honey-producing hives that one skilled beekeeper can work efficiently is 500, with one or two unskilled assistants. Two skilled beekeepers working in partnership and having a couple of unskilled assistants can operate 1,000 hives, and furthermore they are in a more secure position. There is always the chance that a beekeeper might fall sick at a critical time of the year. If there are two skilled people working in partnership, then the danger of severe loss through sickness is greatly decreased. If the two partners were to employ two skilled apiarists and four assistants, they could run 2,000 colonies.

The potentialities of the tropics for commercial beekeeping have not yet been explored, except in a few places in tropical America. The results obtained there have been most encouraging, and there is no apparent reason why Africa and Asia should not also be capable of supporting numerous profitable bee farms. But first the areas good for bee forage must be found, and productive strains of honeybees must be used in suitable beehives.

II

APIARY EQUIPMENT

Chapter VIII

THE APIARY

Choice of Site—Hive Stands—Out Apiaries—Bee Houses—Advantages af a Bee House—The Construction of Bee Houses.

CHOICE OF SITE

An apiary is a place where a number of bives are kept. In selecting an apiary site various factors have to be takeo into account. First and foremost is the necessity for abundant sources of nectar. The best types of vegetation are the forest and woodlands, thougb certain types of grasslands, wbich support a dense cover of flowering herbs at certain seasons, are valuable. Some agricultural crops which provide many acres of nectar-yielding blossom can be very useful. When only a few hives are kept, tbe necessity for an abundance of oectar plants is not so important, and a few hives can be kept anywhere other than in arid deserts. The economic flight range of the honeybee is up to one mile from the hive, but bigger crops can be obtained, particularly in poor scasoos, if the bees can collect all the crop within half a mile of the apiary. Thus the apiary should be in among or at the edge of tbe sources of nectar.

The second important point is the proximity of permanent water. The bees must have water. During the rains there is usually pleoty, but during tbe dry season many areas dry up completely. Bees living near rivers, even if there is ooly the occasional water-hole during the dry season, do much better than bees out in the dry bush. Bees near babitation always get water which they readily steal from round the kitchen. Choose your apiary sites near permanent water of some sort, or provide a water supply for the bees. The bees take their water from the damp earth at the edges of a water-hole or stream, and they seem to prefer it if it is in the sunlight. The hives should be sited as near the water supply as possible, certainly withio one quarter of a mile.

The apiary must be sheltered from the elements. There should be shelter from high winds; this is easily found in tbe woodlands, but in the open grasslands it is necessary to look for sheltered folds in the ground. Areas liable to flooding should be avoided. Damp

hollows must be avoided and on very high ground the same applies to frost hollows. When hives are sited in valleys, make sure that they are in such a position that there is air drainage. This means siting the hives on a gentle slope where the damp air can flow away.

The hives must be protected against pests, animals and thieves. Primitive hives are usually hung in trees having straight smooth stems. Frame hives will be on stands and the most convenient method of protecting the hives from ants is to place a flat piece of tin at the top of each leg and smear the underside with Ostico banding grease. Primitive hives can also be placed on stands protected in this manner. To protect the hives from stock, the apiary should be fenced. Strong wire-netting dug into the ground at the foot gives some measure of protection against the smaller predatory mammals. If there is danger from ratels, martens or thieves, then bee houses should be used for sheltering the apiary.

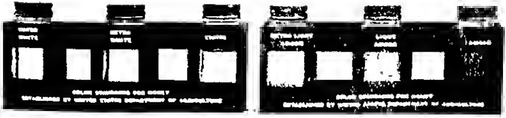
Owing to the danger from grass fires and from ants, all herbs and grass should be cut back well clear of the hives, and if convenient the ground can be covered with gravel or ashes.

It is also an advantage for the hives to be shaded from the mid-day and afternoon sun. If the hives are hot the bees waste a lot of energy, and honey, in trying to keep the hives cool. It has been shown that in hot climates hives in the shade produce 10 to 40 per cent more surplus honey than those in the sun. Trees with dense foliage which make the hives damp with constant dripping must be avoided. Where the rains are heavy and prolonged the shade should be made weather-proof to keep the hives dry.

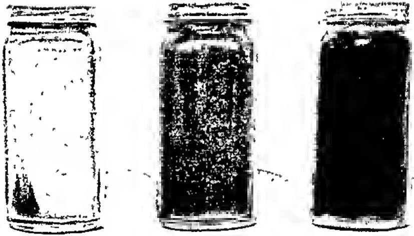
Keep out of sight of roads and footpaths, not only to reduce the chances of pilfering, but also so that people and animals passing by do not get stung; the bees do not like rapid movements near the hives.

The maximum number of hives which can be placed in any one apiary depends entirely on the available nectar. Usually the maximum is fifty hives in any one apiary and apiaries of that size should not be sited closer than two miles apart. However, smaller apiaries of twenty to twenty-five hives sited one to one and a half miles apart may prove more profitable. When selecting apiary sites, find out what other hives are in the area so as to eliminate the danger of over-stocking.

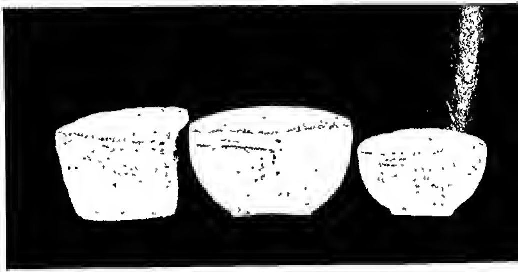
When a suitable site for an apiary has been found and permission of the owner of the land has been obtained, a track is cleared to enable a truck to get right into the apiary. The positions of the hive stands are marked and the ground cleared of vegetation. It is better



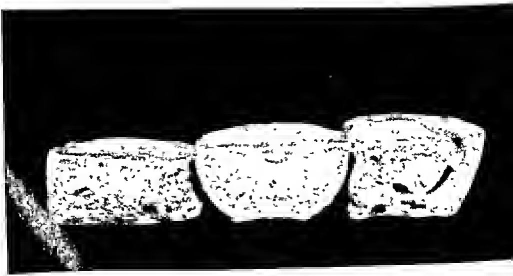
IV. Colour grading set for honey



V. One pound jars of honey, extra light amber, light amber, and amber



VI. Clean cakes of beeswax



VII. Dirty cakes of beeswax

to arrange the stands so that they are staggered or in squares. If put in straight lines there is a tendency for the bees to drift, usually towards the end hives. A good arrangement is to have the hives in pairs on the stands and adjacent stands facing different directions.

HIVE STANDS

Hive stands with legs are absolutely necessary in the tropics to give protection from ants and other pests. A stand which is recommended is made of two 2 in. by 3 in. runners, 4½ ft. long. The ends of the runners are tied by two pieces 20 in. long so that the outer edges of the runners are 20 in. apart. Four legs, 2½ ft. long, of durable termite-resistant timber and well soaked in creosote, are dug in to support the runners at about 18 in. above ground level. A piece of tin, about 6 in. square with a ¼ in. hole in the centre, is placed on top of each leg. A 6 in. nail is driven through the runner, through the hole in the tin and into the leg. Make sure that the stand is level along the runners. There should be a slight inclination towards the front of the stand so that any water which might get into the hive can run out of the entrance. The undersides of the pieces of tin are smeared with banding grease.

If sawn timber is expensive, the stands can be made of slotted steel angle. It has the advantages of being lighter and more durable than wood, and very quickly assembled.

OUT APIARIES

Out apiaries are sites where bees are kept away from the beekeeper's base. Bees may be sited anywhere on public land but permission must be obtained before they may be sited in forest or game reserves. If the beekeeper wishes to put his hives on private land, he must obtain the permission of the owner. Permission is almost always given readily enough, and it is usual for the beekeeper to pay a nominal annual rent of a dozen jars of honey to the landowner for each full-sized apiary.

Most operators of out apiaries restrict their apiary system to a radius of thirty miles, though particularly profitable sites may justify the expense of additional travel to fifty miles. Migratory beekeeping sites may be much further afield. If by moving a long distance an additional crop can be obtained, at a time when the bees on their normal sites would be gaining nothing, then the expense of the move may be more than justified by the extra crop gained.

BEE HOUSES

Under certaio conditions it pays the heekeeper to keep his hives in hee houses. If tbe usual method of siting hives on stands in the opeo is used, and the heekeeper finds that the hives are heing robbed by thieves or hroken up hy the ratel or marten, he would be well advised to consider the use of hee houses. Also, should he find that the hees are uncontrollahle in the open, and he is unable to carry out any management on frame hives, theo he will find the solution in putting the bives in a hee house.

A hee house is a small huilding with a strong bee-tight door and well-veotilated windows, fitted with a hee-escape arrangement. The hives are inside round the walls; the ends of tbe hives which contain their entrances are in contact with the walls, the entrance holes corresponding with holes through the walls. The bees fly in and out of the hives through the walls witbout entering the room itself. The whole construction of the house must be such that there are no cracks through which hees can enter the room. The building can be made of any materials locally availahle, so long as it is strongly and soundly built.

ADVANTAGES OF A BEE HOUSE

The main advantages of hee houses under tropical conditions are as follows:

1. The hives are in total shade, and are therefore cool; this tends to make tbe bees less vicious; they have less fanning to do and can therefore spend more time foraging; this results in bigger crops.
2. The hives are protected from ratels, martens and thieves.
3. The hives cao be at a convenient beigbt for working, instead of heing hung in trees.
4. The beekeeper can work on the hives in daylight, using smoke to control the bees and without fear of being attacked by guard hees. These guards are mostly near the entrance to the hive, and they will fly around outside the house, but tbey cannot get in to attack the beekeeper working in the room.
5. From twenty to fifty hives can be accommodated in a single house. This makes for greater efficiency in working, as the beekeeper merely moves from hive to hive in the house. The beekeeper's ability to produce more, and so earn more, is increased.
6. Tbe bee bouse can be sited oear permanent water, within a

quarter of a mile. If there is no water in the area it is worth while either digging a permanent water-hole or providing water in some sort of tank. The water could be collected off the roof during tbe rains.

7. As tbe hives are easily placed in position in the hee house, they can be stocked with swarms or transferred colonies. The bee-keeper using simple hives is no lnnger entirely dependent upon the arrival of stray swarms for stocking his hives.
8. The heekeeper, able tn control the hees and to work in peace, can carry out manipulations nn his hives to increase production. The ease and cnmfort in which the work is done makes heekeeping a pleasurable occupation, and the heekeeper will therefore he more inclined tn study his bees and so improve his metbod of management.
9. Demonstration of beekeeping tn students hecomes a reasonable proposition. A bive made nf glass can be used in the bee house for instruction in the biology of hees. It is also most suitahle for advanced and delicate operations such as queen raising and royal jelly production.

The main objection to bee houses is the capital cost. But this is justified if their use makes profitable heekeeping practicable.

THE CONSTRUCTION OF BEE HOUSES

An internal width of 8 ft. gives adequate room for a row of hives along each wall witb plenty of space down the middle. This width enahles ceiling hoard to he used without wastage and the short span makes roofing economical.

The length of the house depends upon the number of hives the house is to contain. If simple hives are used, they can be quite close together and can be in twn or three rows at different heights along eacb wall. For fifty simple hives the internal length of the bee house can be 24 ft. Frame hives cannot be worked conveniently on different levels. It is hest if the frame hives are arranged in pairs, about 5 in. between each of the twn hives of a pair, and a gap of 18 or 21 in. between one pair and the next. In this way each hive can be worked from the side, the most convenient position. Here again, if the internal length is in multiples nf 4 ft., the most economical use can be made of ceiling board.

The height from floor to ceiling should be at least 7 ft.

The house should be built nf the strongest and most durable materials available. The door, a full 3 ft. wide to enable hoxes to

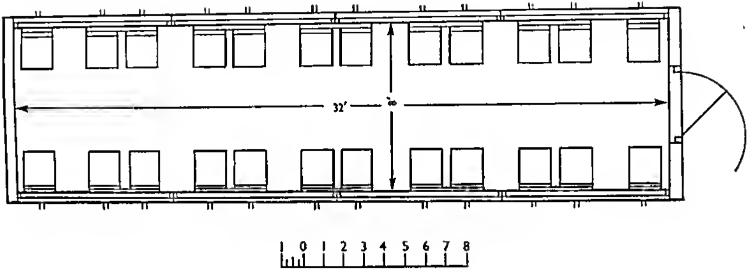


Fig. 13

PLAN OF BEE HOUSE

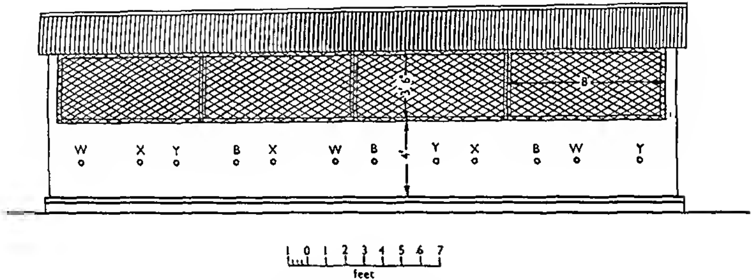


FIG. 14

BEE HOUSE, SIDE ELEVATION

W, White; X, Black; Y, Yellow; B, Blue.

be carried in and out easily, is situated in the middle of one end wall. Strong locks should be fitted to prevent tbieves breaking in. A latch or hook and eye sbould be fitted on the inside to secure the door while work is going on inside.

If simple hives are being used, one window in the middle of the wall opposite the door may be adequate. But in a bee house using frame hives, at least four windows are desirable in tbe side walls to provide plenty of ligbt and fresb air for the beekeeper.

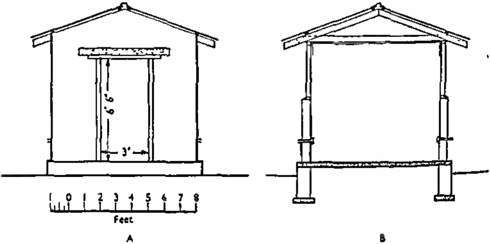


Fig. 15

BEE HOUSE

A, End Elevatioo; B, Section across.

The windows consist of simple frames, 4 ft. or more long by 3 ft. or $3\frac{1}{2}$ ft. high. For protection from thieves or animals, either iron bars can be fitted or expanded metal secured to the outer face of tbe frame. On the ioner face of tbe frame is fasteoed wire gauze; mosquito gauze will do. A gap about 4 in. wide is left between the top of the wire gauze and tbe frame. A board—ceiling board or tempered hardboard serves very well—about 8 in. wide, is fitted on the inside of the frame aloog the top, overlapping tbe wire gauze by 3 or 4 in., aod spaced $\frac{3}{8}$ in. from it by means of thin strips of wood running vertically. This forms the bee-escape. Any bees in the room fly to the light and crawl upwards between the board and tbe gauze and then out over the top of the gauze.

For frame hives, the entrance holes should be about 20 in. above the floor for ease of working. Short leogths of $1\frac{1}{2}$ in. piping or bamboo make excellent entraoce tunnels through the wall. As it is seldom possible to get the plaster absolutely flat, and it is not

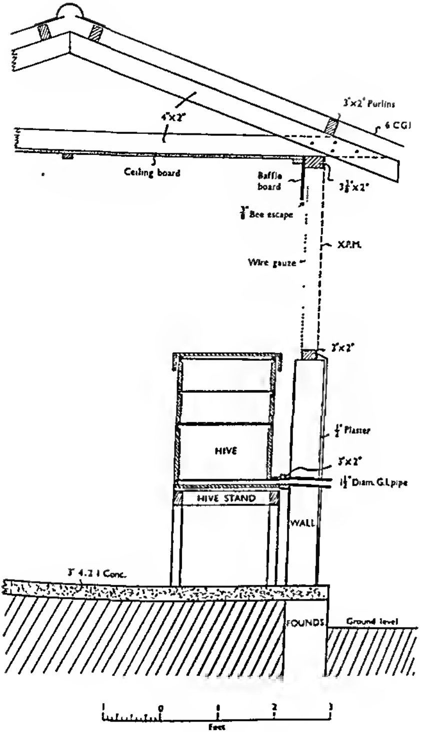
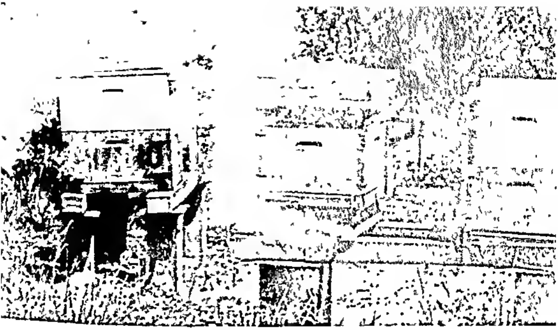


Fig. 16

BEE HOUSE, DETAIL

desirable to have frame hives pushed flush against the wall, a length of 3 in. by 2 in. timber is secured to the wall on the inside. Holes are cut in this 3 in. by 2 in. corresponding to the holes through the wall. The hives are then pushed up against this piece of wood with the hive entrances corresponding to the holes. The surface of the wood can be planed flat so that there is a close fit between it and the hive and no chance of the bees leaking out.

As the bees identify their hives by form, colour and smell, we can assist the bees to find their own holes by painting the entrance or the wall round the entrance with different colours. The colours to use are yellow, blue, black, and white, because the bees can easily distinguish between them. In order to avoid repetition of arrangement which might confuse the bees, a suitable sequence for colouring the entrances would be: white, black, yellow, blue, black, white, blue, yellow, black, blue, white, yellow, and then start again, white, black, yellow, blue, and so on.

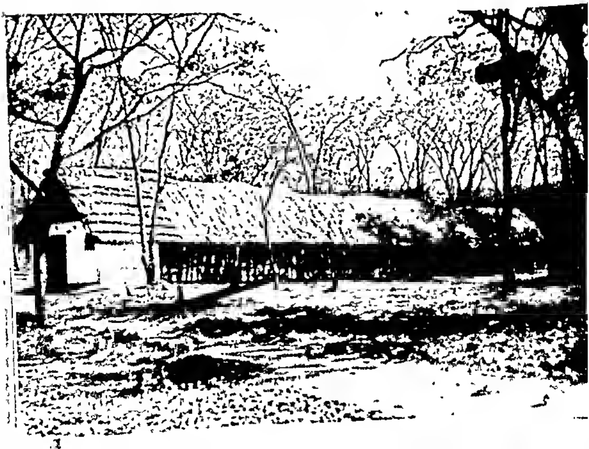


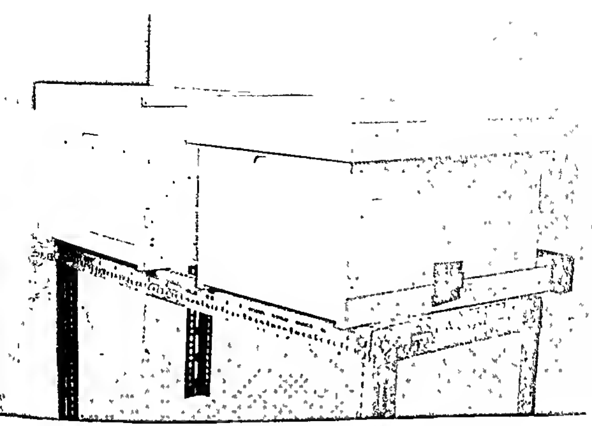
28. Scale hive in a woodland apiary

29. *Brachystegia-Julbernardia* woodland, the source of most of Africa's beeswax

30. An apiary in Europe, sheltered from the wind and ready for the winter

31. Apiary shelter with a storeroom in woodland in Tanganyika





32. Modified Dadant hives in a bee house. Note the bee-tight arrangement for the hive entrance

33. A well-shaded apiary in Northern Rhodesia

34. Primitive hives resting on the branches of a smooth-stemmed tree

35. A bark hive bound with straw and suspended from the branch of a tree, Tabora, Tanganyika

Chapter IX

SIMPLE HIVES

Cylindrical Hives—Skeps.

CYLINDRICAL HIVES

OF all the primitive types of hives used in tropical countries, those made from bark or logs are the most common. Whatever the material used, the form is almost always cylindrical, and the hives are used either in a vertical or a horizontal position. The bark hives are made either from the whole bark peeled from the tree and then held together with pieces of stick, or from the inner bark, after the rough outside has been removed, turned inside out and sewn. The logs may be hollowed through from the ends or split lengthways and then hollowed. Bark hives are usually bound with straw to protect them from the sun and the rain. In some parts, the hives consist of clay cylinders or are made of woven cane.

One disadvantage of the bark and log hives is that large numbers of trees are killed to obtain the materials. Further, in Africa, the trees which have bark most suitable for hive-making are *Julbernardia* and *Brachystegia* species, the most important honey-producing trees in the woodland. The native beekeeper is thus destroying the very vegetation that produces the nectar in his efforts to make more hives.

Management of cylindrical hives is quite impossible. Usually they are baited with wax to attract swarms and in due course they are opened up and the bees robbed of their comb. If they are hung in trees, as is normal in Africa, it is quite impossible to do anything else with them. Further, the materials with which some of the primitive hives are made do not lend themselves to accurate construction; they are liable to have cracks in the wrong places, through which bees leak out, and it is difficult to fit them properly in a bee house.

In the past there have been attempts to use queen excluders in primitive hives. The idea was to divide the hive into two chambers, one of which would be used by the queen for brood rearing and the other would be used solely for the storage of honey. The idea was good but unfortunately the bees do not always behave as required,

in fact in the writer's experience, in 98 out of 100 hives it does not work. This is actually the wrong use of a queen excluder; even with frame hives one does not put a queen excluder between two empty boxes.

SKEPS

Here it is appropriate to describe what is possibly the most successful simple hive ever used, the Pettigrew skep. Pettigrew was a Scots gardener and was the most outstanding advocate of the skep in Europe at a time when all manner of experiments with frame hives were proceeding, and much was being added to the beekeeper's knowledge about bees. One of the most important aspects of his approach was that he appreciated that the bees must have hives big enough to develop the colony to full size if good crops were to be obtained. The traditional types of skeps were too small and the new frame hives being introduced in England suffered from the same fault. The crops he obtained with his large skeps and intelligent management shame the efforts of many beekeepers using frame hives even today.

Skeps are made of ropes of straw, about 1 in. in diameter, sewn with split canes or bramble briars. Pettigrew's hives have vertical sides and a flat top. In the centre of the top a hole 4½ in. in diameter is left, and a lid is provided to cover it. The internal dimensions are 18 in. diameter and 14 in. high, capacity 2·1 cu. ft., the same as the Modified Dadant brood box. In the bottom rope is cut a hole, 4 in. long by 1 in. high, to provide entrance and ventilation for the bees. The skep is stood on a flat board.

Usually a small piece of comb is stuck to the inside of the top of the hive to act as a guide comb and to start the bees off building the combs in the right direction. Five or six sticks are pushed through the straw from side to side and parallel to each other, the bottom sticks at least 4 in. above the floor. The guide comb ensures that the bees build their comb running from front to back. They fix the combs securely to the sticks, thus preventing the combs from collapsing should the hive be struck or shaken. When harvesting the crop, before cutting out the combs, the cross-sticks are drawn out with a pair of pincers.

If it is desired to enlarge the hive, either a shallow skep called a super is placed over the hole in the top, after removing the cover, or a straw rim, called an eke, the same diameter as the walls of the hive and about 4 in. high, is placed between the hive and the floor board. When rims, or ekes, are used, cross-sticks are put through them near the top. The ekes are fastened to the hive by nails or staples going into both.

Skeps must be sheltered from the sun and from rain. In the tropics, the hives must he protected from ants. Skeps can also be kept in bee houses.

Wooden hoxes can be used in the same manner as straw skeps. They too should have a capacity of ahout 2 cu. ft., 18 in. square inside and 11 in. high, with a 4½ in. diameter hole in the top. This hole is covered with a slab of wood except when the bees are being fed or a super is placed in position. The box has no bottom but stands on a flat wooden hase. Wooden ekes and supers can be used as with the straw skep.

Chapter X

FRAME HIVES

Commercial Types of Hives—Components of Frame Hives—The Floor Board—The Brood Box—Shallow Supers—Inner Cover—Telescopic Roof—Queen Excluders—Frames—Ordering Hives.

THERE are innumerable patterns of hives in use in the world and the greatest variety is to be found in Europe. Every beekeeper develops his own idea of an ideal hive according to his approach to beekeeping. The man who keeps bees purely for a hobby can afford to indulge in all manner of fancy gadgets and fittings. As the leadership of the beekeeping fraternity in Europe has long been in the hands of hobbyists, there is a mass of fancy hives and even the so-called standard types are unnecessarily complicated. The prospective commercial beekeeper, who develops among the complications of hobbyist beekeepers, has an uphill struggle wrestling with his unsuitable equipment. As a result, there are few successful commercial beekeepers in Europe, and those are they who had the courage to break away from the traditional orthodox ideas of the hobbyist leaders and adopt greatly simplified equipment.

Unfortunately, the use of small fancy hives has been introduced from England into India, particularly in the south. As the strains of honeybees in the plains of India do not have very prolific queens, and are not very industrious, the hives were made even smaller than the hives of the English hobbyists. This was a retrograde step from which beekeeping in South India has not yet recovered. To reject the use of modern commercial hives on the grounds that the bees are not prolific or productive enough to be of any use in large hives, is to prevent the development of economic beekeeping.

The most urgent task in India and South Asia is to breed strains of bees which will fulfil the requirements of maximum productivity. If suitable strains cannot be developed from the indigenous bees, then importations must be made from other parts of the world which do have productive bees suited to tropical conditions. But that is a subject for a later chapter on bee breeding.

If you are going to keep bees merely as a hobby and do not mind how much money you spend on it, then by all means buy fancy hives.

If you want to keep a few hives for the purpose of obtaining honey and do not want to throw your money away, use the simple type of equipment described in this book. If you want to become a commercial beekeeper, then start as you will continue, using commercial-type hives.

COMMERCIAL TYPES OF HIVES

There are four hives made to exactly the same design, but differing only in dimensions. Two of these, the Smith and the British Commercial, are used only in Britain. The other two, the Langstroth and the Modified Dadant, are used in many countries of the world, wherever commercial beekeeping has developed. The Langstroth hive was originally designed in 1851 as a single brood chamber hive, but in the course of time, with improvements in the strains of bees and beekeeping technique, it was found that one brood box was too small for a good queen. Nowadays the Langstroth hive is used with two boxes for the brood chamber, and often brood boxes are used as honey supers. The Dadants experimented with larger hives and in 1917 introduced the Modified Dadant hive to meet the demand for a simple single brood chamber hive which would accommodate the good strains of honeybees used by commercial beekeepers. The Modified Dadant hive takes eleven frames the same length as those of the Langstroth but $2\frac{1}{8}$ in. deeper and spaced at $1\frac{1}{2}$ in. centre to centre. The normal Langstroth hive holds only ten frames spaced at $1\frac{3}{8}$ in. centre to centre. Although the natural spacing of the combs of European bees is $1\frac{3}{8}$ in., the Dadants suggested $1\frac{1}{2}$ in. spacing as a measure to reduce swarming. It may do so, but, because the bees cannot cover so much brood as with the natural spacing, it retards the development of the brood nest. The natural spacing of $1\frac{3}{8}$ in. should be used for the best results with European bees. This permits the use of 12 frames in the M.D. brood box. With African and Indian bees the natural spacing of $1\frac{1}{4}$ in. should be used; 13 frames in the M.D. and 11 frames in the Langstroth brood box.

Clearly, it is not possible for a bee farmer who is equipped with Langstroth hives to scrap them and change over to Modified Dadant. Such a change can be made only as equipment wears out, and well-made hives last a long time. The Modified Dadant hive is increasing in popularity and is becoming more widely used, particularly by bee farmers who have become established during the last thirty years.

Some beekeepers consider that there should be only one standard hive. That would be reasonable enough in a country where beekeeping conditions are identical in all parts. However, in tropical countries there are vast differences in climate and vegetation and

almost the whole range of variation exists in each territory. I would not suggest making just one hive the standard, because, while it might be ideal for one set of conditions and some forms of management, other conditions may require other forms of management for which another hive might be more suitable. For instance, I know of one beekeeper in tropical Africa who uses Langstroth hives and he finds that under the conditions in his region, a single Langstroth brood box is inadequate for the brood nest, while two brood boxes provide too much room. Therefore he uses a Langstroth brood box plus a shallow super for the brood nest, when a far better plan would be to use the larger Modified Dadant brood box. There would then be a saving in capital equipment as two sets of frames and foundation cost almost twice as much as one set of larger frames. Also there would be a saving in time and labour as it takes less than half as long to check one set of brood frames as it does to check two sets one on top of the other. If one has to find the queen in a strong colony, it is easier to do so in a single eleven-frame Modified Dadant brood box than in a Langstroth hive with twenty frames in the two chambers of its brood nest.

Personally, having used both Langstroth and Modified Dadant hives in the tropics of Africa, as well as in temperate climates, I thoroughly recommend the Modified Dadant, provided that your queens are good enough to utilize the full capacity of the M.D. brood box, as they should be if you are going to make a business of beekeeping.

A point about the use and misuse of frames requires mention. A frame is a tool designed for a specific job. A brood frame is designed for the most efficient use in the brood chamber. A super frame is designed for the storing and extraction of the surplus honey. Now, if you have to use a shallow super to enlarge your brood nest, then you have to have a shallow brood frame. Thus, instead of having only two patterns of frames, you have three, deep brood, shallow brood and super. You might use brood frames in the honey supers as is done by many owners of Langstroth hives, but they are not designed for that job, with the result that they are less efficient for extraction than the proper super frames. This sort of thing does not matter very much to the beekeeper with just a few hives, but when you are managing hundreds of hives and handling tons of honey, it matters a lot.

There is one super frame which can be used with both hives and which has been proved by extensive use to be the most efficient, the Manley frame, 6¼ in. deep, used in supers 6⅝ in. deep. The shallower 5⅜ in. deep frame is not recommended.

COMPONENTS OF FRAME HIVES

Both the Langstroth and Modified Dadant hives are identical in design but differ in dimeosioos. At the bottom is the floor hoard, having an entrancc block with which the entrance can be adjusted in size or closed completely. On the floor board stands the brood box. This is a rectangular box consistiog merely of four boards. In the top of the front and rear walls is cut a rabbet from whicb hang the frames. These frames are composed of four pieces of wood, the top bar having projecting ends which rest on the rabbets. Tbere is a space of hetweeo $\frac{1}{4}$ in. aod $\frac{3}{8}$ in. between the ends of tbe frames and the walls of the hive and over the frames between the top bars and the top of the walls. This is known as tbe bee space, which is kept clear by the hees, thus enabling the framcs to be removed easily. Sbould this space he less than $\frac{3}{16}$ io. the bces are liable to seal it up with propolis. If more than $\frac{3}{8}$ in. they may build pieces of comb in it. Thus hives aod frames must be made accurately if the principle of the movahle frame hive is to be maintained.

Within the frames are fixed sheets of beeswax on whicb are embossed the impressioos of the bases of the worker cells. The fouodatioo forms the midrib of the comb aod the bees build tbeir cells oo hoth sides of the sheets. In order that the combs will he really secure and huilt ceotrally in tbe frames, horizontal wires are passed througb the eod hars and are embedded in the foundatioo. Tbe hives can theo he moved around witbout any danger of the combs collapsing. Some manufacturers make foundation with vertical or oearly vertical wires already embedded in the wax. The beekeeper merely secures the loops in tbe wires to the top bar of tbe frame. This type of foundation has been tried and found unsatisfactory in a warm climate when hives are moved any distance by road or rail. I bave had 90 per cent of tbe combs slide down the wires on a long journey in Tanganyika. Dadant and Sons in America and E. H. Taylor Ltd. of Welwyn, Herts, England, now make a ready-wired foundation having wavy or crimped wire running vertically througb the foundation. This will be a great improvement on the plain wires. All manufacturers make foundation with the cells the correct size for European bees. For African and Indian bees special foundation with the smaller size cell bases is obtainable. While African bees will draw out European size foundation, better results are obtained if the correct type is used.

Over the brood box is placed a queen excluder, which is made of wires or perforated zinc having holes through whicb the workers can pass but too small for the passage of the queen with her larger thorax.

Sbe is thus confined to tbe brood box where she lays her eggs. Tbe workers cao pass througb to build comb aod store booey io the supers above. Supers are boxes similar to the brood box but shallower and are placed over the queeo excluder. Tbey are fitted witb frames specially designed for the storing aod extraction of honey.

Over the supers go the covers. Tbey consist of a flat inner cover, usually of strong plywood baving a rim round tbe edges oo the upper side aod a hole in the middle for feeding or fitting a bee-escape. A telescopic roof, covered with sbeet metal, fits over the top.

A clearer board is used to remove tbe bees from the supers when ooe wants to collect tbe crop. This is a flat board, witb a rim like ao inner cover. In tbe centre tbere are one or two oval holes ioto whicb bee-escapes fit. The Porter bee-escape is a cootrivaoce througb which the bees cao go one way, but they cannot return. With the use of the escape board the bees can be cleared from the hooey super in about two days.

Tbus a frame hive oornally consists of a floor board with an eotraoce block, one brood chamber containing frames and foundation, a queen excluder, two or three shallow supers cootaining super frames aod foundatioo, an ioner cover and telescopic roof, and a clearer board with ooe or two bee-escapes.

FLOOR BOARD

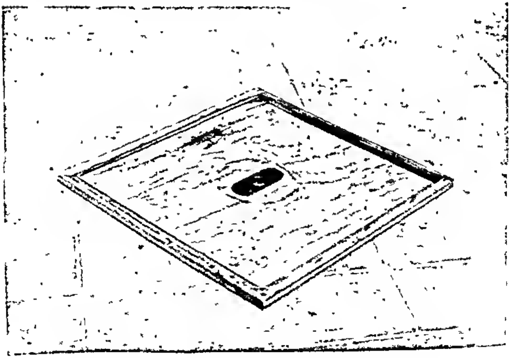
Some floor boards are made with a projecting piece in front called ao alightiog board. If the hives are kept oo stands in the open this is unnecessary. The bees do not require it. Nature does not provide it for colonies living io hollow trees or caves; and if the bees wanted it they would make it tbemselves out of propolis. Alighting boards are a waste of timber, they make packiog bives for transport more difficult and tbey catch the rain which splasbes into the hive, makiog it uonecessarily wet. Some bives have a porcb fitted to keep the rain off the alighting board; that is going from bad to worse; more wasted timber, more projections. However, if the hives are kept in a bee bouse, the 2 in. projectioo is useful, if covered with a board to form a tunnel betwcen the hive and the hole io the wall through whicb the bees fly.

The floor board coosists of twn side runoers, 2 io. high, $\frac{7}{8}$ in. wide and 20 in. or 22 in. long. The runncrs are grooved oo the inside. The groove is $\frac{3}{4}$ in. wide by $\frac{3}{8}$ in. deep, cut $\frac{7}{8}$ in. from the top cdge. Betweeo the side runners, with their eods fitting into the grooves, are boards $\frac{3}{4}$ io. thick and $17\frac{1}{2}$ in. long in M.D. hives ($15\frac{1}{2}$ in. long in Langstroth hives), having a total width, when tongued and grooved

36. Bark stripped from a tree to make a hive. The tree is killed by this treatment

37. A crude bark hive secured by pegs

38. A Langstroth hive with two brood boxes and two supers (*left*) and a Modified Dadant hive with one brood box and two supers (*right*). The floorboard of the hive on the left ends flush with the front of the hive; this is suitable for outside use. The floorboard on the right is the full 22 inches long, projecting 2 inches in front of the hive. The projection is covered with a piece of wood for use in a bee house



39. An inner cover with a Porter escape in the hole

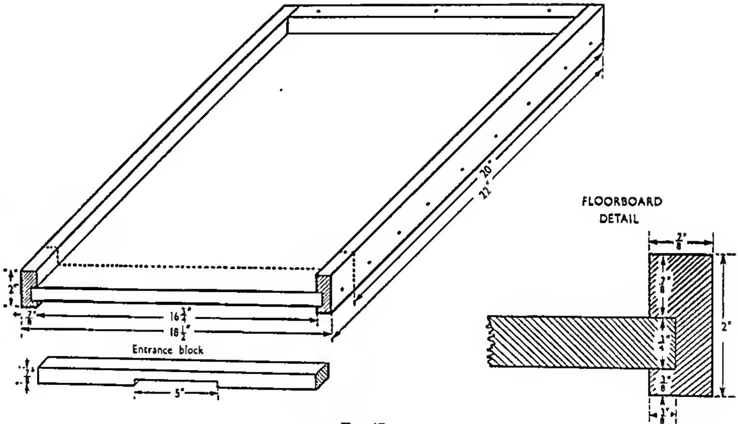


FIG. 17
FLOOR BOARD, M.D.

together, of 20 in. or 22 in., corresponding to the length of tbe side runners. Between the *runners at the* back *of* the floor board is fitted a piece ⅞ in. by ⅞ in. by 16¾ in. in M.D. (⅞ in. by ⅞ in. by 14½ in. in Laogstrotb), filling tbe space between tbe side runners. Another piece ⅜ *in.* by ⅞ in. hy 16¾ in. (or 14½ in.) is usually supplied for the same purpose on the otber side of tbe floor board to make it reversible, but it may be more usefully employed to fill the gap under tbe floor board to prevent lizards from lurking there. The dimeosions of the completed floor board are: Modified Dadant 20 in. or 22 in. loog by 18½ in. wide (Langstroth 16¾ in. wide).

The entrance block is made from a piece of ⅞ in. hy ⅞ in. timber 16¾ in. long (14½ in. long in the case of Laogstroth). A piece 5 in. by 5/16 in. is cut out from one side of the block to make a small entrance. When the hlock is turned the other way it can he used to close the entrance for moving. A stud is driven into eacb side runner to prevent the entrance block from being pushed in too far.

BROOD BOX

The brood box is composed of four pieces of ⅞ in. timber, 11⅝ in. wide for M.D. (Langstroth 9 9/16 in. wide). Internally the length for both hives is 18¼ in., externally 20 in. M.D. boxes are 16¾ in. wide inside and 18½ in. wide outside (Langstroth 14½ in. wide inside, 16¼ in. wide outside). The internal dimensions must be adbered to strictly. On the two shorter sides, a rabbet ⅞ in. by 7/16 in. is eut along tbe top. A metal strip is nailed along eacb rabbet to present a hearing surface for the frames, ⅝ in. from the top of tbe box. Tbese ruoners are essential for ease of manipulation of tbe frames *in the* hrood box. Hand bolds are usually cut in all four sides of the brood hox. Factory-made hives have lock-jointed corners. Rahhet joints are very satisfactory and butt joints can be used provided they are screwed.

SHALLOW SUPERS

The length and breadth of shallow supers are exactly the same as for the brood boxes. Some users of Laogstroth hives use hrood boxes for supers, others use shallow supers. The depth of the M.D. super, that is the width of the boards, is 6⅝ in. This depth can also be used with Langstroth hives. The M.D. super holds ten super frames and the Langstroth shallow super can hold nine of the same type of frame. It is not necessary to have metal ruooers in the supers because the frames are not normally manipulated once the super is on the bive, therefore the rahhets *in* the end walls are only ⅝ in. hy 7/16 in. Hand holds sbould be cut in *all* four sides.

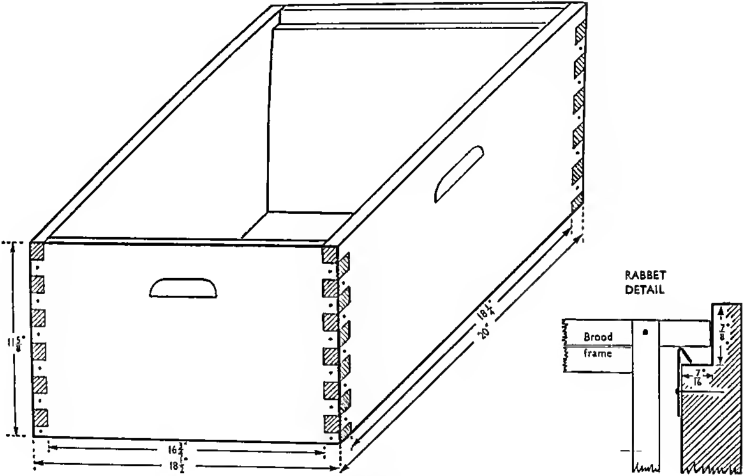


Fig. 18

BROOD BOX, M.D.

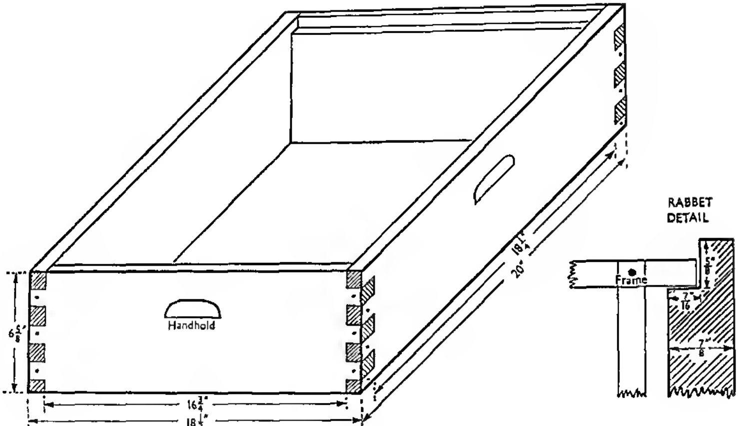


FIG. 19
SHALLOW SUPER, M.D.

INNER COVER

The inner cover or crown board is the same size as tbe external dimensions of the brood bnx. It consists of a sbeet of strong plywood or thin boards having a rim of ⅞ in. by ⅜ in. wood on the upper side. The reason wby an inner cover is used with a telescopic roof is that the bees fix everything up tightly with propolis. A sharp flat lever or hive tonl can be inserted under the flat inner cover to loosen it but it is not pnssible to get a tonl in to loosen a telescopic roof.

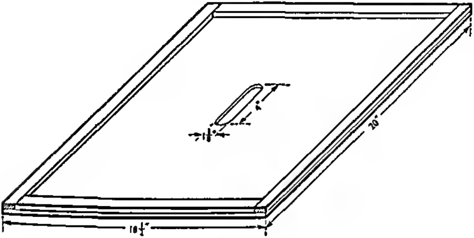


FIG. 20

INNER COVER, M.D.

One or two boles, 1⅛ in. wide and 4 in. long with rounded ends, are provided for fitting Porter bee-escapes. Thus the inner cover can he used as a clearer board. Some beekeepers prefer to have a deeper rim on their clearer bnards sn they have hoards specially made for that purpose. The hole in tbe inner cover enahles it to he used wben feeding bees and alsn provides top ventilation when used under a *telescopic roof.*

TELESCOPIC ROOF

The telescopic roof or outer cover is usually made of ½ in. or ⅝ in. hoards. A rim 3 in. deep is made, with internal dimensions 20¼ in. hy 18¾ in. for Modified Dadant (Langstroth 20¼ in. hy 16½ in.). The boards are nailed over the rim and the roof covered with sheet metal. Provision must he made fnr ventilation. One method is that sbown in tbe drawing. Another method is to place four pieces of

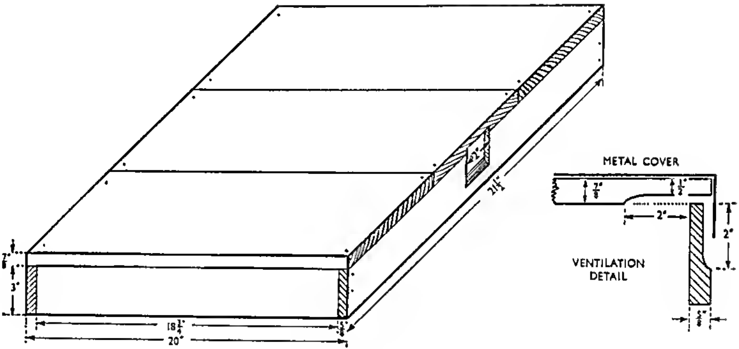


Fig. 21

TELESCOPIC ROOF, M.D.

wood ¼ in. to ⅜ in. thick, one in each corner of the roof, thus raising it ahove the rim of the inner cover.

The above-mentioned parts can he made in any well-equipped joiner's shop. The timber selected must he thoroughly seasoned and the movement with cbanges in humidity must not he greater tban ⅛ in. in tbe width of the boards which are used for making the hody hoxes or supers. This ⅛ in. is the tolerance in the hee space which must he hetween ¼ in. and ⅜ in. The wood should he durable, resistant to insect and fungus attack and sbould he as light as possihle The hest timher for hive making is Western Red Cedar, *Thuya plicata*. This is used hy hive manufacturers in tbe United Kingdom. There are several timhers availahle in the tropics wbicb, while not being quite as good as Western Red Cedar, will serve very well.

In temperate climates commercial types of beebives are generally treated with a good wood preservative such as creosote, solignum or cuprinol. Tbis may well he the best treatment in tbe higher altitudes and moist climates of the tropics. This treatment does not block up the pores of the wood and helps to prevent condensation in tbe hive. In hot dry climates the floor hoards sbould be soaked in creosote and the hrood boxes, supers and roofs given at least two coats of good white paint to reflect the heat and so help the bees to keep tbe hive cool. Treated hives should he well aired before heing put into use.

QUEEN EXCLUDERS

The outside dimensions of queen excluders are 20 in. by 18½ in. for M.D. hives (Langstrotb 20 in. by 16¼ in.). Tbere are two types of queen excluder in common use, the wire or wood and wire excluders as made hy Waldron in the U.K. and the sbort slot zinc excluders. Do not bave anything to do witb long slot zinc excluders; the metal bends easily, resulting in enlarged slots whicb let the queen througb. The zinc excluders require to be framed with ⅞ in. hy ⅜ in. strips and the corners reinforced with pieces of plain zinc. A piece across the centre is necessary to prevent sagging. The Waldron excluders are obtainable ready framed. The size of the slots and distance hetween the wires in queen excluders bas to be very exact; the tolerance is in the order of two- or three-thousandths of an inch. It is not possible to make them accurately by band. This is an item whicb has to be purchased.

FRAMES

Frames are made so accurately and cbeaply by machinery that uoless you bave the use of accurate woodworking machines, it is not worth trying to make them by hand.

Frames are composed of a top bar, a bottom bar and two eod pieces. The top and bottom bars of M.D. aod Langstroth brood frames are exactly the same. The only differeoces are in the end bars. M.D. end bars are 11¼ in. long aod 1½ in. wide, while Langstroth end bars are 9⅛ in. long and 1⅜ io. wide. The M.D. end bars can be 1⅜ io. wide for European bees. With Africao and Asiao bees the end bars of brood frames should be only 1¼ in. wide.

When ordering brood frames specify whether plain or split bottom bars are required. Plain bottom bars are used when you wire your own frames and embed tbe wires into plain foundation. Split bottom bars are used with ready-wired foundation to ensure that the sheet of foundation lies in the centre of the frame.

The brood frames are spaeed apart by the width of the upper third of the end bars. Tbese frames are known as Hoffman self-spacing frames and are the best for use in the brood boxes. They are not so suitable for use in the supers. Special frames have been designed for the storage and easy extraction of honey.

The best super frame that has ever been designed is the Manley frame. This is 6¼ in. deep and can be used with Langstroth as well as M.D. hives. A Modified Dadant super holds ten of these frames and a Langstroth super, made to the same depth as the M.D. super, holds nine. The end bars are usually made 1⅝ in. wide but in the M.D. super they may be $1\frac{43}{64}$ in. for a good fit. The top and bottom bars are both the same width, 1⅛ in. These dimensions are such that the comb is built by the bees with the cappings of the cells of the honeycomb protruding on both sides of the top and bottom bars. To uncap the comb, a knife is drawn along in contact with both the top and bottom bars, neatly removing the cappings in one quick movement. With some strains of bees in the tropics it may be found that the width of the top and bottom bars should be slightly less for easy uncapping. In Tanganyika we are now using Manley frames witb end bars $1\frac{43}{64}$ in. wide and top and bottom bars $1\frac{1}{32}$ in. wide. The super frames are not made for ready-wired foundation. They have to be wired and the wires embedded in the foundation, unless one is working for cut comb. In that case, the foundation or starter is merely attached to the top bar with melted wax. A starter is a narrow strip of foundation ½ in. to 1 io. wide attached to the top bar to ensure that the bees build their comb in the frame. A newly hived

swarm is given three or four brnnd frames with starters so tbat it can cluster naturally while building its first combs, and starters are used in super frames wben the production of wax is of more importance than the production of honey.

ORDERING HIVES

Considerable annoyance and inconvenience are sometimes caused to both beekeeper and manufacturer because articles ordered are not properly described or specified. In nrder to guide beekeepers in the terms to use, a list of tbe parts nf a hive is given here. Although only two supers are mentioned, you may require three or four for each bive.

One Modified Dadant Hive, complete, consisting of:

1 Floor Board, witb entrance block, having entrance cut on one side only.
1 M.D. Brood Box, with metal runners and hand holds on all four sides (in the flat).
2 M.D. Shallow Supers, with hand holds on all four sides (in the flat).
1 M.D. Queen Excluder, 20 in. by 18½ in. (Waldron or framed zinc short slot).
2 M.D. Inner Covers with Porter escape holes.
2 Porter Bee-Escapes.
1 M.D. Roof, metal covered and ventilated.
11 M.D. Deep Brood Frames with plain bottom bars (or 12 at 1⅜ in. spacing; or 13 frames 1¼ in. wide for use with African or Asian bees).
20 Manley Shallow Super Frames.
2 lb. M.D. Deep Brood foundation, not wired (11–13 sheets; specify whether for European, African or Asian bees).
2 lb. M.D. Shallow Super Foundation for Manley Frames (20 sheets).
1 oz. Metal Eyelets for end bars of frames.
4 oz. Frame Wire.
2 oz. Gimp Pins, ⅞ in., for nailing frames.
1 lb. Wire Nails, 1¼ in., for nailing hives.

Note well the following points:

(*a*) Floor boards are required only 20 in. long, without any projecting alighting board if they are to be kept on stands in the open;

(*b*) Entrance blocks to have the entrance cut in one side only so that when turned the other way they can be used to close the hive completely.

Chapter XI

ASSEMBLING FRAME HIVES

Brood Box—Supers—Painting Hives—Brood Frames—Super Frames—Nailing Frames—Wiring Frames—Embedding—Securing Foundation in Unwired Frames.

BEEKEEPERS who obtain their equipment from overseas can purchase floor boards and roofs already made up. The 20 in. floor board, inner covers and queen excluder will pack in the roof. Brood boxes and supers should be ordered in the flat to save on freight costs. Frames are supplied in the flat in any case as they do not pack well when made up.

BROOD BOX

The brood box is composed of four pieces of timber, two of which are longer than the other two. The two shorter pieces have a rabbet cut along the inside of the top. In addition to the four pieces of wood there are two metal runners which fit on the rabbet as shown in the diagram. To assemble the brood box, fit the corners together, making sure that the hand holds are on the outside, and knock them into place with a mallet or piece of wood. Then make sure that you have got the box square. One-and-three-quarter-inch nails are the best to use. Drive a nail through the centre of each of the lugs with the exception of the lug butting on to the end of the rabbet. If you put a nail in there you will either split the wood at the back of the rabbet, or the nail will merely pass into the rabbet itself and subsequently foul the frames. After nailing all four corners, again make sure that the box is square. Then fit the metal runners. If you punch small holes in the metal first, you can secure the runners with $\frac{7}{8}$ in. frame pins.

SUPERS

The supers are composed of four pieces of board, like the brood box, only narrower, resulting in a shallower box. Metal runners are not used in the supers and the rabbets are not so deep in consequence. As with the brood boxes, you knock the corners together, making

sure that each side is the right way up, and square off. Then nail through the lugs, and check again that the corners are square.

PAINTING HIVES

The floor boards should be thoroughly soaked in creosote and allowed to dry in the fresh air. The entrance blocks are similarly treated. The brood boxes, supers and roofs should be given a good layer of white undercoat, well worked in at the cracks at the corners. When this is thoroughly dry, one or two coats of white gloss paint are applied. This paint must be suitable for outside use. If the hives are going to be placed in lines, it is useful to paint the front of the brood boxes over the entrances with different colours to enable the bees to identify their own hives easily and so stop drifting. The colours to use are black, white, yellow and blue. Only the outsides of the boxes and roofs are painted; it is not necessary to paint the insides. The hives should be well aired before use. If the hives are not going to be out in the sun, but in total shade or in a bee house, they can be soaked in Cuprinol to preserve the timber, instead of being painted.

BROOD FRAMES

Before assembling the brood frames, the end bars should be bored with $\frac{3}{32}$ in. or 2·5 mm. holes. These holes should be made 2 in. apart and dead in the centre of the end bar. A Modified Dadant frame will require five holes and a Langstroth frame four holes. (See the diagram.) The metal eyelets should be inserted in the holes next. Lay the end bar on the table with the broad end away from you. Make sure that the V-edge is on the right. Then insert the eyelets. An awl is a useful tool for this. Several eyelets are threaded on to the awl and then the point is put in the hole and the awl pushed until the first eyelet is in place. After withdrawing the awl, tap the eyelet lightly with a pin hammer so that it lies flush in the wood.

SUPER FRAMES

If you are working for extracted honey you will require two wires in your super frames. Bore two $\frac{3}{32}$ in. or 2·5 mm. holes in the centre of the end bars and put in the eyelets. (See diagram.) If you are working for comb honey only, you do not want wires, so you can leave your end bars undrilled.

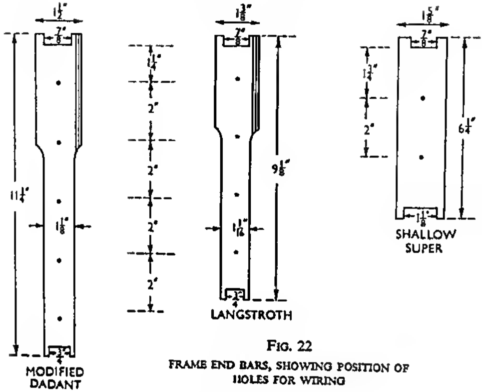


FIG. 22

FRAME END BARS, SHOWING POSITION OF HOLES FOR WIRING

NAILING FRAMES

When the end bars have been drilled and the eyelets inserted you can put frames together. Some beekeepers use cold casein or resin glue for this and find it very satisfactory; others use ¾ in. or ⅞ in. frame pins. When assembling the frame, fit the end bars with the eyelets on the outside. When you hold the frame the right way up, the V-edge of the end bar on the left should be towards you and the flat edge of the end bar on the right towards you. This is necessary to ensure that the frames fit properly in the brood box. The pins must be driven through the shoulders of the end bars into the lugs of the top bars, and on both sides of the frame. Similarly, drive pins through the bottom shoulders of the end bars into the bottom bar. Do not rely on pins driven in vertically through the top bar into the top of the end pieces. There is no strength in this and your frame will only collapse when it is full of comb. Always drive pins in from the side through the shoulders of the end bar into the lugs of the top bar, and do it on both sides. (See diagram.) A tip to remember, if you dip the end of a nail or frame pin into beeswax, it will then drive into the wood more easily.

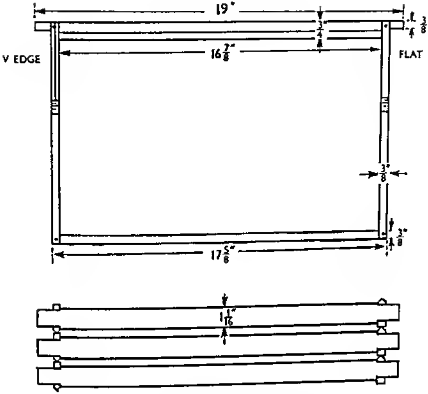


Fig. 23

CORRECT ASSEMBLY OF BROOD FRAMES

WIRING FRAMES

For wiring frames, rig up a jig, as illustrated, on your work-bench and make a holder for your reel of wire, so that the wire will not slip off the ends of the reel. Secure to the bench a long piece of wood for the top bar to rest against. Nail two pieces of wood ½ in. thick at each side of the frame so that the frame will not move sideways when you pull the wires. Place a small block of wood against the centre of the bottom bar so that it presses it in slightly. Nail cotton reels so that they revolve easily in each place by the end bar where you will have a loop of wire. (See diagram.) Having made your jig, put in the frame with the top bar towards you and the bottom bar squeezed in by the small block of wood.

Starting at the hole nearest the top bar, on the right if you are right-handed and on the left if you are left-handed, thread the wire through, passing it round the cotton reels at each loop. When you have passed the end of the wire through the last hole next to the bottom bar, drive

two frame pins partly into the sides of the end bars, one by the bole wbere tbe wire starts and one by the hole where the wire finishes. Wind the loose end of the wire round the pin nearest tbe bottom bar and drive the pin rigbt in. Pull the wire tight. Take tbe loop off the cotton reel nearest the bottom bar and pull it tight again. Repeat

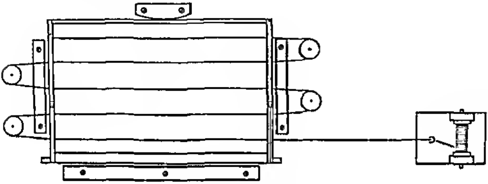


Fig. 24

JIG FOR WIRING BROOD FRAMES

according to the number of wires in the frame until all the wires are tight and twang wben touched. Then, still holding the wire tight, wind the reel end of the wire round the pin nearest the top bar and drive the pin in. Cut the wire and remove the frame from the jig. All the wires should now be tight and emit a twang. Make sure that there are no loose ends of wire protruding from the end bars; cut them short and tap them into tbe wood.

EMBEDDING

The best way of embedding the wires into the comb foundation is to do it electrically. For current you need two cells of a car battery, 4 volts. The embedder is made from a piece of wood 18 in. long and about ¾ in. square. Four nails are driven through the wood, evenly spaced, with the end nails 16½ in. apart. The two centre nails should project ⅛ in. more than tbe two end nails. Numbering the nails from one end, one wire is attached to No. 1 nail and also to nail No. 3. The other wire is attached to nail No. 2 and to No. 4. It is best to solder the wires on to the nails. When you connect the two wires to the battery and touch your frame wires with any two adjacent nails, the current will flow along the wires between the two nails. Four volts is quite sufficient to heat the wire and cause it to sink neatly into the wax foundation.

To do the actual embedding, cut a slab of wood ½ in. thick to fit neatly into the frame. Lay the wood on the bench. Slide one edge of a sheet of foundation into the groove in the centre of the underside of the top bar. Make sure the frame is square. Place the frame, with the foundation in its groove and with the wires uppermost, over the block of wood prepared for the frame. The foundation should now lie flat on the block of wood, with the wires lying on top of the foundation and in contact with it. Place the points of No. 1 and No. 2 nails in contact with the wire and it will heat and sink into the wax. As soon as the wire has sunk in sufficiently, raise No. 1 nail, keeping No. 2 still in contact, and touch the wire with No. 3 nail. The centre section of the wire will then heat and embed itself. Then raise No. 2 nail, keeping No. 3 in contact, and touch the end of the wire with No. 4 nail, and the final section will become embedded. Then proceed in the same manner with the rest of the wires. With a little practice you will find that you can embed the wires very rapidly; it only takes about one second on each section of wire, and the finished job is as neat as you could wish. You may find it necessary to rub the points of the nails on the bench occasionally to remove any wax that has accumulated on them. With the wires embedded in the foundation, the frames are ready for use.

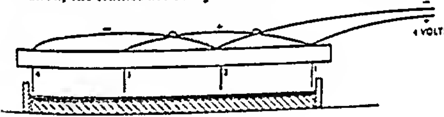


FIG. 25

ELECTRIC EMBEDDING TOOL

SECURING FOUNDATION IN UNWIRED FRAMES

To secure foundation in unwired super frames, put the edge of the foundation in the groove in the underside of the top bar and holding the foundation centrally in the frame, pour a little melted beeswax along the groove. This will hold the foundation in position. Unwired frames would be used in supers only when you want to be able to cut out the comb honey to eat as it stands. For this you would use thin super-grade foundation. Brood frames must always be wired, as also must super frames which are going to be transported by road from the hive to the extracting shed, or which will be used in a centrifugal honey extractor.

Chapter XII

OTHER EQUIPMENT

The Smoker—Hive Tools—Bee Veils—Bee Gloves—Overalls—The Workshop—Equipment for Moving Bees.

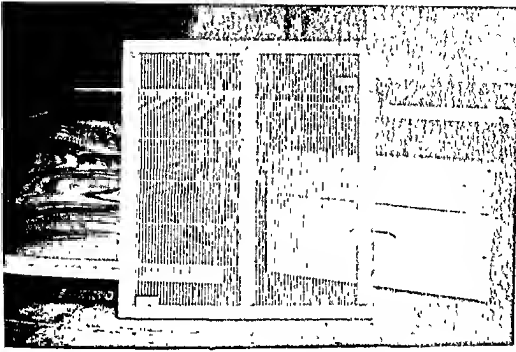
THE SMOKER

In order to control the bees effectively, every beekeeper must have a good smoker. The best type is marketed as tbe American or Empire smoker and is of the bent-nose type. If a number of hives have to be attended to, use one of tbe large Jumbo smokers. A large smoker does not require refilling so often and the delay caused by having to recharge a small smoker while in the middle of dealing with a difficult colony can be disastrous. A hook on the back of the bellows is very useful as it enables one to hang the smoker on the side of the hive while handling the frames. For fuel for the smoker, old rotten sacks cut into strips are excellent.

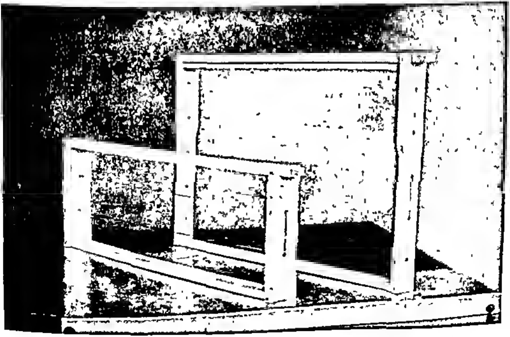
HIVE TOOLS

Wben working with frames a proper hive tool is oceded. This is a flat piece of steel, sharpened at one end for inserting between hive boxes to separate them, aod beot over at the other end for separating the frames. The bive tool sbould be strong enough to bear your wbole weight oo it wheo separatiog supers full of honey. It should be a bright colour so that it can be seen easily if dropped in the grass. The tool I like best is made of stainless steel, so is easily spotted if dropped in the dark. It is 8 io. long and the flattened ends are just under 1½ in. wide. The ceotre part which is gripped in the palm of the hand is 1 in. wide. The turn-over at the bent end should not be more tban ¼ io. or ⅜ in. When working with the hives the hive tool is in the hand all the time, so you do oot want it to be large and clumsy.

For working witb simple hives it is a great help if special tools for cutting out tbe comb are used. Ooe is a long flat bar, 20 to 24 in. long and about 1½ in. wide, sharpeoed like a chisel at one end. This is used for cutting the combs away at the sides. The other is an iron



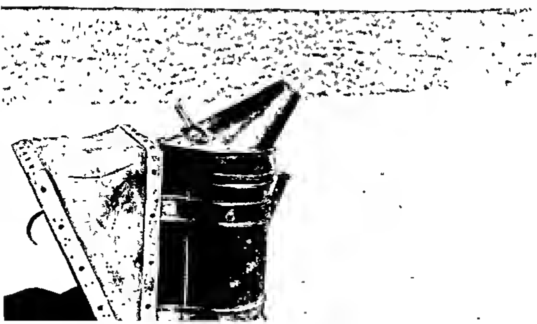
40. A Waldron queen excluder



41. A Manley super frame (*left*) and a Modified Dadant brood frame (*right*)

46. Dressed ready to c
with the most vicious b

47. Smoker and hive tool



rod of the same length and about $\frac{3}{16}$ in. diameter. At one end a narrow blade $1\frac{1}{2}$ in. long is fitted to protrude at right angles to the handle. This is used for cutting away the comb at the top.

BEE VEILS

It is most important that the face should be well protected from bee stings. There are many types of bee veil on the market and individuals have their own preferences. One that has proved itself under the severest conditions is the folding wire and cloth veil. The ordinary round wire and cloth veil would no doubt be equally efficient, but it is not so easily packed away. Care should be taken to buy only those with cloth top and bottom, and the elastic threaded through the hem of the cloth at the top should be adequate to fit round the hat firmly but not tightly. Similarly, the elastic at the bottom should be sufficiently long to enable the cloth skirt to be drawn well away from the neck. Some wire veils have netting top and bottom, supposedly for coolness, but it has been found that that type is not strong and also the bees sting through the netting if it happens to touch the neck.

There are two tapes fitted to the bottom edge at the back and these are brought forward under the armpits and threaded through two loops in front. The tapes are then passed back under the armpits, crossed behind and tied in front. It is an advantage if the two loops are fitted with metal rings such as curtain rings. The tapes can then be threaded through quickly and easily and they do not wear the loops.

BEE GLOVES

Bee gloves, if used, should be strong but supple, with gauntlets which come up over the sleeves and have elastic at the tops. The best gloves obtainable are made of horse-hide and have moleskin-material gauntlets. These are very durable and are as sting-proof as any. Care should be taken to insist on this pattern as some of the gloves marketed are far too flimsy and are neither sting-proof nor hard-wearing. Others are at the opposite extreme, being too stiff and clumsy. A point to note is always to turn the elastic in under the material of the gauntlet. If the elastic is exposed, the bees tend to sting into it.

OVERALLS

While a long-sleeved drill shirt and drill trousers answer very well for working with bees, it is best to have a special pair of overalls.

These should be made of white drill in the boiler-suit style, with long sleeves, long trousers and all in one. The best fastening up the front is a heavy-duty zip, but if zips are not obtainable, at least twelve buttons should be used. Never wear dark or woolly materials when working with bees; they always go for such materials. Drill has the advantage of being smooth as well as pretty sting-proof.

The ankles must be well protected as vicious bees always attack them. High boots or gaiters should be worn and they will both protect the ankles and at the same time stop the bees from their disconcerting habit of climbing up inside the trouser leg.

THE WORKSHOP

The needs of the beekeeper in respect of workshop facilities are simple, provided he buys his hives ready-made, but in the flat. A bench, 36 in. high, is needed for assembling, wiring and fixing foundation in frames. A lower bench, 20 in. high, is very useful for assembling, nailing and painting brood boxes and supers.

A wooden mallet, claw hammer and a square are needed for assembling the boxes. A smoothing plane is useful for removing any inequalities in the height of the walls of the boxes which might arise if the wood was not fully seasoned when the boards were cut. Two good paint brushes for the undercoat and the final coats on the boxes and roof, and a third brush for creosote complete your requirements for assembling the hives.

For assembling frames you need a pin hammer, and hand-drill and a supply of $\frac{3}{32}$ in. or 2·5 mm. bits, a bradawl for inserting the eyelets, a small pair of wire cutters, and the embedding tool. If electricity, even in the form of a four-volt battery, is not available, a spur embedder can be used. This is a small milled wheel on a handle which is warmed in a flame and run along the wire to embed it in the foundation.

For making your hive stands, if of wood, you will need a hand saw, a brace and $\frac{1}{4}$ in. and $\frac{3}{8}$ in. bits and a level. I recommend a long mason's level, 18 or 20 in. long, for levelling the hive stands. A pair of tin shears will come in useful for cutting the pieces of metal to go on top of the stand legs.

Equipped with a supply of $1\frac{1}{4}$ in. nails, gimp pins, metal eyelets, frame wire, 6 in. nails, white undercoat paint, white finishing paint, creosote, small quantities of black, yellow and blue paints, some Ostico banding grease, and you are ready to start setting up your apiary.

EQUIPMENT FOR MOVING BEES

When migratory beekeeping is practised, some additional equipment is needed. Each bive must bave a travelling screen, consisting of a framed piece of wire gauze which is fitted in place of the cover to provide ventilation. Crate staples, 2 in. wide, are used to hold the hive parts together, or wedge clips can be used. A strapping machine using ½ in. steel tape is very useful. For carrying large numbers of hives, a lorry with a flat platform back is best. The hives can be roped on far more securely on a platform body than on a cargo body. Also the platform body is far easier for loading and unloading.

III

BEE MANAGEMENT

Chapter XIII

THE MANAGEMENT OF PRIMITIVE HIVES

Cylindrical Hives—Skep-type Hives—The Prime Swarm—Making an Artificial Swarm—Secand Swarms—Turnouts—Uniting—Stack Hives—Remaving the Cambs—Migratory Beekeeping with Skep-type Hives—Application af Skep-type Beekeeping.

THE hive is the beekeeper's principal tool. As a tool it has to be suited to the partieular form of management that the beekeeper wishes to use. A hive is not superior to any other in itself, but it may be in its suitability for the method of management. Provided that the hive is suffieiently large for the full development of the colony and gives adequate protection against enemies and the elements, it is the management of tbe hive whicb determines the amount of surplus boney and beeswax obtained by tbe bees, all other things being equal. It is no use baving expensive and complicated hives if they are not managed in a manner wbicb will produce crops sufficiently large to justify tbeir expense and complexity.

CYLINDRICAL HIVES

The cylindrical type of primitive hive whicb is designed to be suspended or secured in a tree is very limited in the scope of management whicb can be applied to it. Management of cylindrical hives consists merely of baiting them by rubbing bot beeswax inside or standing the hive over a small fire witb a piece of beeswax smouldering in tbe embers. Tbe stronger-smelling wax of stingless bees makes the most efficient bait. This baiting is done as near to swarming time as possible. Swarming usually takes place at the beginning of the honeyflow periods. The hive is hung or fixed in a tree and left for a swarm to find it. If a bive has not been occupied during the first swarming season, tbe baiting sbould be renewed at tbe beginning of the next swarming season.

Nothing is done to the hive until the honey-collecting season. In the case of a hive whicb bas been occupied by bees only that season,

the size of the colony is often not sufficiently large to enable tbe beekeeper to remove any booeycomb without seriously impairing the ability of tbe colony to survive the subsequent period of deartb. A hive that bas been occupied for more than one season should have enough surplus comb to enable the beekeeper to collect a crop, provided that tbe bees bave been able to obtain water all through the year.

In Africa, where the boneybees are inclined to defend their hive vigorously, most of the beekeepers prefer to collect tbe crop at night. Using a bundle of burning twigs which provides light to see by and smoke to cootrol the bees, the beekeeper is liable to destroy the colony. Io areas where the bees can get water all through the year, the beekeepers have learned that it pays to preserve the bees and leave tbem some comb to live on. A colony so preserved will produce a bigger crop in the next year than bives which have been completely robbed out aod may or may oot be occupied by swarms later. In areas where there is no water during tbe dry season, the bees will abscond after consuming their stores, so the beekeeper robs them out completely.

The more advanced primitive hive beekeeper takes only tbe clean honeycomb aod leaves the dark brood combs with the honey in them for the bees.

The cylindrical hives can be kept in a bee house. In fact, tbis is the best way of keeping them in tropical Africa. The hives may be hung up in trees to attract swarms and then put in tbe bee house, or swarms may be transferred into the hives. The best results are obtained if the bees are allowed to become established in the hive while still in the tree and transferred to the bee house at the beginning of the honeyflow. Swarms put into hives must be fed in order to enable them to build comb and establish their brood nest. Kept in the bee house the colonies are cool and more manageable and the crop can be collected in the daytime with the minimum of effort. The bee house must be either sited near permanent water or a permanent water supply provided. Once the hives have been put into the bee house, aoy cracks in the hive must be sealed up so that the bees do not leak out ioto the room.

SKEP-TYPE HIVES

The traditional skeps are made of straw, but wooden boxes can be used in the same manner. In fact, in the tropics, wooden boxes appear to be preferable to the straw skeps owing to the trouble caused by pests.

Skeps must be kept in shade and shelter from the rain or in bee houses. Their management has been developed to a fine art and here I will outline the principal points in the technique evolved so successfully by Pettigrew (1). The system depends upon the natural or artificial swarming of the bees.

The operation of the swarming system is founded on the theory that the stimulus of an empty hive makes the bees work harder. There appears to be evidence that swarms construct combs far more economically than established colonies in terms of honey consumed. Further, a swarm, having nothing, must build combs and collect stores as rapidly as possible if it is to survive.

The swarming system enables the stock to be renewed each year, that is, the old queens can be replaced easily by young vigorous queens in the course of routine management without any special queen-raising operations. Further, no hive of comb is kept for more than two years, so there is not the same wax-absorbing accumulation of cocoons and pollen in the brood combs as occurs in combs which have been bred in for years. Also no great quantity of drone comb develops, with the result that the maximum amount of worker brood is produced.

For the swarming system to be of real value, large-size hives must be used and ekes added as required. Particulars of the hives were given in Chapter IX (p. 106).

THE PRIME SWARM

At the end of the build-up period, when the colonies are really strong and the honeyflow is beginning, which is the time at which colonies often swarm naturally, an artificial swarm is made from each hive. The swarm, with the queen, is dumped into an empty hive fitted with cross-sticks and guide comb. The parent colony is moved on to another stand and the swarm in its new hive is stood where the parent colony used to stand. The swarm will thus collect the flying bees and build comb rapidly. The parent colony will raise a new queen from the young brood in the hive.

MAKING AN ARTIFICIAL SWARM

An artificial swarm is made by driving some of the bees out of their hive. The hive to be driven is smoked sufficiently for the bees in their alarm to fill themselves with honey. Allow the bees a few minutes to do this. Then carry the hive away a few yards. Place an empty hive, prepared with cross-sticks and comb, on the spot where the hive had stood. The flying bees will go into this instead of trying to enter

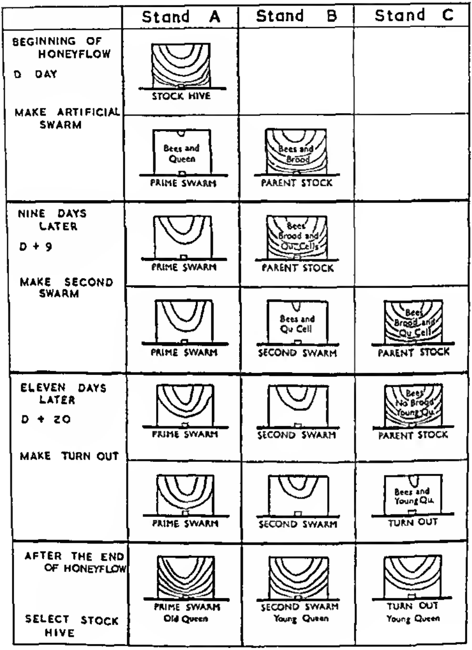


FIG. 26

MANAGEMENT OF SKEP HIVES

neighbouring hives. The stock to be driven is turned upside down and over it is placed the mouth of an empty hive. A piece of cloth is wound round the junction of the two hives to keep all the bees inside. Long staples or driving irons can be used to secure the two hives together and prevent them from moving during the operation. The stock is now driven by drumming with the palms of the hands for five to ten minutes on the sides of the lower hive which contains the colony. This drumming causes the bees, and most probably the queen too, to run up into the empty hive. One can check that the queen has run up with the rest of the bees by taking the upper hive containing the swarm and turning it upside down. The queen is usually distinguished running among the bees. When she has been seen, the swarm is taken back to the old stand and shaken into the hive which has been standing there catching the flying bees. Before shaking the swarm into the hive, it is well to check the original stock to see that enough bees have been left to cover the brood. If too many have gone up, put a handful or two back, if too few, drive some more. The parent stock is then put on another stand.

SECOND SWARMS

With really powerful colonies it may be possible to take off a second swarm as soon as the queen cells are ripe and the virgins ready to emerge. In that case, at least two queen cells are cut out intact and put carefully on one side, protected from the sun and cool winds. About half the bees are driven and a ripe queen cell given to each hive. If there are mature virgins imprisoned in the cells, they can be released and allowed to run in, one into each hive. Alternatively, if the virgins are not quite ready to emerge, the cells themselves may be put in the hives. In the case of the empty hive, a depression is made in the guide comb and the cells inserted. Similarly, in the parent stock the cell is fitted into the comb. Great care must be taken not to allow the queen cells to become heated in the sun or chilled. After taking them from the hive they should be placed in a box among cotton-wool, the right way up. The hives containing the parent stock and the second swarm should be placed one on each side of the original site, about six feet apart, so that the flying bees will be divided equally between them.

It is recommended that the beginner does not try making second swarms until he has obtained experience of the size of colonies required to produce good crops.

TURNOUTS

The parent hive may now be allowed to build up aod store hooey. If the hive is already full of comb, the weakened pareot colony is unlikely to store more honey than it cao accommodate io its existing comb. Thus no new wax will be made. Twenty days after tbe prime swarm was made, provided that the major part of the honeyflow still lies ahead, a turnout can be made. Between nineteen and twenty-one days after the prime swarm was driven, according to the strain of bees, the last worker eggs laid by the old queen hefore she left the hive will have hatched. Thus there will be no worker brood io the hive other than a few eggs a quickly mated new queen may have laid. Possibly some drone brood will still remain as it takes tweoty-four days to hatch, but that is of oo consequence. In those circumstances, all the remainiog bees, which will have heen reinforced by the emerging brood, are driven out into a new hive. This is termed a turnout. In making turnouts, drumming is needed for fifteen minutes or more. The hive cootaining the turnout is placed on the stand and the hive of comb is takeo away for the crop it cootains to be removed. The turnout itself, provided the honeyflow is on, will rapidly build comb and store booey.

UNITING

Should secood swarms or turnouts be small, they cao be united to the second swarms or turnouts of other hives. It is best to uoite hees about sunset. The hive to receive the bees is turned over and some sugar syrup is sprinkled over the bees. The swarm to be united to it is shaken in on top of the other bees and some more syrup is sprinkled on them. The hive is now returned to its stand. The sprinkling with sugar syrup helps greatly to stop the bees from fighting. The queens will fight it out between them and the fittest will survive. It is best to put hives which you intend to unite side hy side for a few days before the union actually takes place, so that the bees to he united become accustomed to the site.

STOCK HIVES

Before taking up any hives at the end of the season, it is necessary to decide which colonies are to be kept for stock. Prime swarms are not suitable because they have old queens and will be extremely heavy with honey. The colonies selected should have a medium

amount nf comb and have queens of tbe current year. The bees are driven out of the hives containing the prime swarms, and also out nf the lightest hives which dn nnt cnntain sufficient fond for the bees tn live nn during the cnming perind of dearth. The bees that have been driven out are united up to the cnlonies which are to be kept fnr stock. Thus colonies with immense numbers nf bees and with ynung queens are kept fnr the next year. They must have adequate stores. Secnnd swarms and turnnuts weighing between forty and fifty pounds make excellent stnck hives.

REMOVING THE COMBS

As soon as the bees have been driven out, the hives should be securely cnvered tn prevent robbing. As soon as possible take them indoors. First draw out tbe cross-sticks with a pair of pincers. Then, using the long hive tools described in Cbapter XII, cut out the combs. The subsequent preparation of the honey and beeswax is described in Chapters XX and XXIII.

MIGRATORY BEEKEEPINO WITH SKEP-TYPE HIVES

Skep-type hives containing colonies of bees can be moved long distances. Tbe provision of cross-sticks enables the bees to fix tbe combs firmly. Ample ventilation must be provided. The cover on the hole nn top is replaced by a piece of wire gauze. The floor must be removed and a large piece of wire gauze secured under tbe bottnm of tbe hive and tied on firmly. Twn battens about 1½ in. square are nailed to the bnttnm of the bive tn keep tbe gauze frnm coming into contact with tbe floor so that the air can circulate freely under tbe bive.

If it is to be a regular practice tn move skeps around as in migratory beekeeping, and a large number are to be moved at a time, it is more convenient tn have an entrance about halfway up tbe side. The hives can be prepared beforehand for a journey and upper entrances left open until the last minute, when they are plugged quickly with a wad of sacking.

APPLICATION OP SKEP-TYPE BEEKEEPING

It can be seen that skep-type beekeeping is a big step forward from the primitive cylindrical hive beekeeping. The beekeeper can apply his skill to the management nf the hives for the production of bigger

crops; he can improve the strain of his bees hy careful selection of his stock hives. This type of beekeeping is recommended for all those who cannot afford to invest in frame hives, or who live in areas where frame hive beekeeping is not economical.

REFERENCE

1. PETTIGREW, A. (1889). *The Handy Book of Bees*, 5th. ed. (Edinburgh).

Chapter XIV

STOCKING FRAME HIVES

Hiving Swarms—Transferring Bees—Package Bees—Nuclei and Stocks

HIVING SWARMS

THE simplest way of stocking a hive with bees is by putting a swarm into it, if you are lucky enough to find one. The ideal swarm is one which has clustered low down on a bush or the bottom branch of a tree. All you have to do is to shake the bees with a sharp jerk into a box or direct into a hive. Be careful to shake the main mass of bees into the box so that you will be sure of getting the queen. Turn the box over on to its lid gently and place it, raised up off the ground, in the shade of the bush or tree. If the queen is inside, the bees which have taken wing will soon be seen rushing in and fanning furiously at the entrance. In the evening, take the bees to your hive and dump them in. If you are shaking the bees straight into the hive, remove half the frames first, and then when the bees are in, replace the frames. Put the cover on but leave the entrance open until all the bees are inside. The bees should be put on to their permanent stand and fed that evening. Continue feeding as much sugar syrup as you can to get the bees established. Twenty pounds of sugar syrup is the minimum they should be fed.

Occasionally bees abscond after being hived in this manner, but if you can put in some frames of drawn comb you should not have any trouble. If you have no drawn comb, make sure that the bees have got clustering space in the shape of three or four frames fitted with starters only. It is unnatural for a cluster of bees to be split up by thin sheets of wax. A cluster is, in the natural state, either split up by drawn comb or else, as in a swarm, is not split up at all. This is why so many swarms abscond when hived directly on to full sheets of foundation; it just is not natural. The bees will cluster readily in the frames which are wired but fitted only with starter strips coming down to the top wire. And they will build the comb in the frame very nicely, provided that the frames are properly pushed together. Of course they may make rather a lot of drone comb.

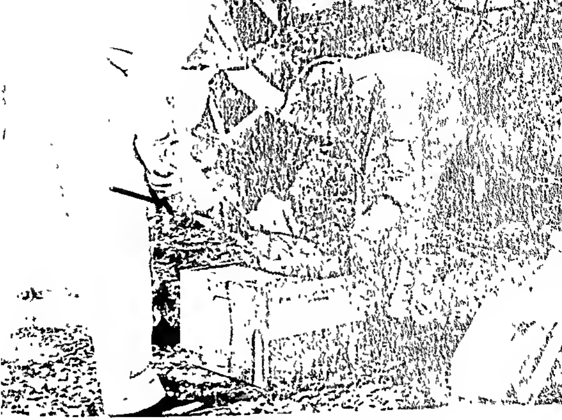
You can put the bees, when hived on to full sheets of foundation, into a cool dark room for forty-eight hours and feed them all the time so that, by the time they are put out on their stand and released, they will have built a little bit of comb and the queen, if with a prime swarm, will have started laying eggs.

A method of keeping newly hived bees in the hive which one hears recommended is to put a queen excluder under the brood box. Do not have anything to do with it. The bees must have pollen, and the excluder acts as a pollen trap, so the bees cannot bring in the food they need for building up. The queen may be a virgin. She will not be able to go out to mate, and the excluder will also trap the drones. And if you forget to remove the queen excluder within a few days, you will do more harm than good. So do not use a queen excluder in that way.

Often we have to remove a swarm from a cupboard or from a packing-case. This is fairly easy, especially if the owners of the premises do not mind putting up with the bees for a few days longer. If the swarm has arrived during the last few days, there will not be much comb. In that case, just brush the mass of bees straight into a hive and take the box they were in a long way away, putting the hive in its place. If the bees are in an immovable cupboard, brush the cluster into the hive, quickly scrape the bits of comb into the hive, and put it as near as possible to the original position of the swarm. In both these cases, if you leave the hive in position for three or four days, the bees will become well established, and you will not have trouble when you take them off to their stand. When hiving bees in this manner, we have found that they will stay on full sheets of foundation, presumably because they have got used to the location. As always when hiving a swarm, commence feeding straight away.

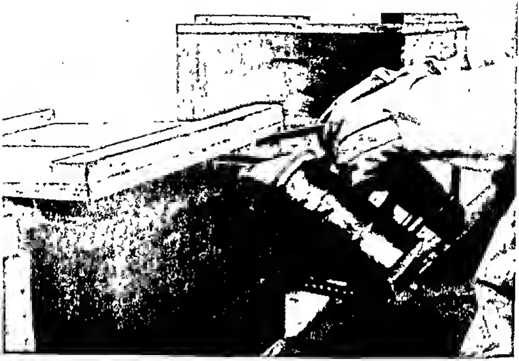
TRANSFERRING BEES

If the bees have been in the box or cupboard for some time, there will be quite a lot of comb built. Use your smoker to drive the bees off the combs and cut them out one by one, carefully brushing off any bees. Then tie them into empty frames, having cut them to shape first. Tie in all the brood combs and some honeycomb too. Do this as far away from the bees as possible, preferably shut yourself in another room while you do it. As soon as the combs are tied into the frames, put them into your hive and place it as near as possible to where the bees were. If the bees have clustered, brush the cluster into the hive and then set it up. If the bees have not clustered, they will soon find the comb in the hive and come pouring in. Leave them

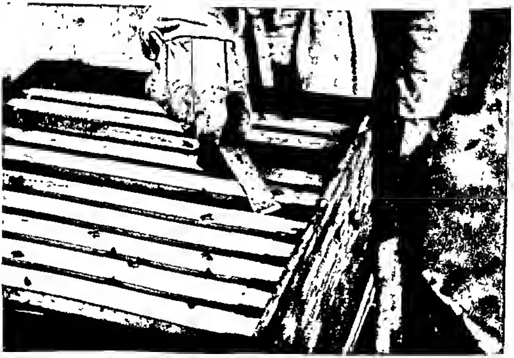


48. Using a net for hiving a swarm

49. The flying bees joining the queen and the rest of the swarm already in the hive



50. Opening a hive



51. Separating the frames using the bent end of the hive tool

for a day or two to fix the comb and then take them off to their stand. Put the feeder on as soon as the bees have gone into the hive.

Bees that have become established in walls or under roofs, unless they are readily accessible, are more trouble than they are worth. When it is a matter of ripping up sheets of roofing iron or knocking holes in brick or stone walls, it is a considerable undertaking, especially when of necessity you are wearing full protective clothing. Either leave the bees where they are and sooner or later they will send out swarms, or, if they have to be moved at all costs, try using a gammexane smoke generator. That usually makes them abscond or kills them. Then seal up all holes leading to the nest.

Bees can be fairly easily transferred from a primitive hive hanging in a tree into a frame hive. The requirements for this operation are a length of rope or wire, a smoker, preferably two, a complete hive with frames of foundation, a few empty made-up frames, some crate staples and a hammer, some string or tape and a knife. The assistance of a boy or two, preferably well protected with veil and gloves, is also required. The first thing to do is to light the smoker and make sure it is working well. One of the boys then climbs up the tree with the rope. If the hive is resting on or tied to the branches of the tree, the boy should also take up the smoker and puff some smoke into the hive entrances before he touches the hive. If it is hanging from a hooked stick, smoking at first is not usually required. Next the smoker should be lowered to the ground. If you have two smokers, this is not necessary. The rope is then tied round the hive, or, in the case of the hanging type of hive, round the hooked stick. The hive is cut loose and swung out over the branch, or the hooked stick is unhooked from the branch, so that the beekeeper can, by gently paying out the rope, lower the hive to the ground.

Before the hive touches the ground, puff some smoke into the entrances. Do not forget that there may be entrances at both ends of primitive hives, and in the split-log hive some along the sides too. Once on the ground, untie the rope and carry the hive away twenty or thirty yards, preferably into the shade. Smoke again and open the end of the hive. See how the combs are hanging and arrange the hive so that it is sloping with the open end uppermost, and in such a position as to put as little strain on the combs as possible. Above the open end, and in contact with it, rig up your frame hive. This should have its floor board removed and the cover fixed on top. Now pound the primitive hive gently but firmly, using some smoke applied at the lower end. The bees will climb up out of the pounded hive into the frame hive. Be careful not to pound so hard as to break the combs. When most of the bees are out of the primitive hive and

in the frame hive, cut out the combs. Cut the brood comb to fit in the empty frames, tie it in with string or tape, and put them into the hive. Also tie in some honeycomb and put that in too. The rest of the comb put into a tin with a lid to prevent robbing. Shake or brush in any clusters of bees, replace the covers and staple the floor board in position, but do not put in the entrance block. Take the frame hive to the foot of the tree in which the primitive hive had been hanging. Secure the rope to the hive using crate staples to ensure that the rope or wire will not slip. Hoist the hive clear of the ground, and make sure that it is hanging level in the rope sling. Then hoist the frame hive up into the tree as near as possible to the former position of the primitive hive. Secure the rope in such a manner that the hive can be lowered easily without jarring it.

Leave the hive hanging in the tree for a day or two, to give the bees a chance to settle down, and to secure the combs in the frames. After a day or two, late in the evening, when all the bees are in the hive, carefully lower it, and quickly slip in the entrance closing block. Then take the hive off to an apiary site at least two miles away. If there is no honeyflow, feed the bees. If they take down their food readily, and if pollen is being brought into the hive, you may be pretty sure that all is well and they are going to stay.

It may happen that the queen gets killed during the transferring, but so long as there are eggs or young brood present in the hive, the bees can raise a new queen. There is a danger of the bees absconding when the virgin goes out to mate. If you have a spare frame or two of young brood that can be taken from another hive and put in the hive containing the virgin, it is unlikely that they will abscond, as bees rarely desert young brood.

PACKAGE BEES

In some parts of the world, package bees are used extensively for stocking empty hives. Package bees are an artificial swarm sold in a container having wire gauze sides. The queen travels with the bees but in a mailing cage. Provision is made for feeding the bees in the package. Sometimes a feeder containing sugar syrup is used, at other times the food consists of a cake of candy. The size of the package is two or three pounds of bees, that is, eight or twelve thousand bees.

A great advantage of package bees is that, being combless, the danger of transmitting brood disease is negligible. Honey should not be used in the food which travels with the bees as the spores of foul brood can be transmitted in honey.

As soon as the packages are received, spray the wire cloth sides

of the containers with sugar syrup and store the packages in a cool dark place. Make sure tbat the hives are ready to receive the hees. There should he five frames in the hive, preferably containing drawn comhs with pollen, otherwise with full sheets of foundation. Pusb the frames over to one side of the hive. Put the entrance block in so that there is only a small entrance. Pack the entrance ligbtly with grass to stop the hees from rushing out straight away; the next day they will be ahle to work their way through the grass and in time they will remove it. Have a full feed can ready for each hive and an empty super to put round the can.

At dusk, hive tbe packages. First feed the bees by spraying the sides of the packages with sugar syrup. When they bave taken all the syrup they want, shake tbem down to the bottom of the package and spray tbem with water to stop them from flying. Take the feeder and the queen cage out of the package. If there is drawn comb in the hive, remove the cover from the open end of the queen cage and place it on tbe floor of the hive, wire gauze side up, and under the frames. If there is only foundation, remove the cover from the candy and scoop out sufficient candy so that there is only just enough to keep the queen in for a few minutes. Shake a few bees into the hive on top of the queen cage and then place the package in tbe hive with the feed hole uppermost. Put on the inner cover and put tbe feed can over the hole in tbe cover. Place the empty super round the feed can and put the roof on.

Two days later, remove the package container and fill up tbe hive with frames. Leave tbe hees alone for two weeks but refill the feeder as often as necessary. About three weeks after hiving, the first brood will start hatching. By that time many of the bees tbat came witb the package will have died. It is an advantage if a frame of brood, with young bees clinging to it, can be put into the hive two weeks after the package was hived. The young bees emerging from this frame help the colony to build up very rapidly.

NUCLEI AND STOCKS

Hives can be stocked by buying nuclei or stocks of bees. A nucleus is a small colony composed of four or six frames of brood and food with all frames well-covered with workers. A stock is composed of eight to eleven frames of brood, food and bees. A nucleus or stock is shipped in a ventilated travelling-case having wire gauze at the top and sides. Care must be taken when ordering nuclei or stocks to state whether they are wanted on Modified Dadant or on Langstroth brood frames.

of the containers witb sugar syrup aod store the packages in a cool dark place. Make sure tbat the hives are ready to receive tbe bees. Tbere should be five frames in the hive, preferably containing drawo combs witb pollen, otherwise with full sheets of fouodatioo. Push tbe frames over to one side of the hive. Put the entrance block io so that there is only a small entrance. Pack the entrance lightly with grass to stop the bees from rushing out straight away; tbe oext day they will be able to work tbeir way through the grass aod in time they will remove it. Have a full feed can ready for each hive and an empty super to put rouod the can.

At dusk, hive the packages. First feed the bees by spraying the sides of the packages with sugar syrup. Wben they bave takeo all the syrup they waot, shake them down to the bottom of the package and spray them with water to stop them from flying. Take tbe feeder and tbe queen cage out of the package. If there is drawn comb in the hive, remove tbe cover from the open end of the queen cage and place it on tbe floor of the hive, wire gauze side up, and uoder the frames. If tbere is only foundation, remove tbe cover from tbe candy and scoop out sufficient candy so that there is only just enough to keep the queen in for a few minutes. Sbake a few bees into the hive on top of the queen cage and then place the package in tbe hive with the feed bole uppermost. Put on the inoer cover aod put tbe feed can over the hole in the cover. Place the empty super round the feed can and put the roof on.

Two days later, remove tbe package cootainer and fill up tbe hive with frames. Leave tbe bees alone for two weeks but refill tbe feeder as often as necessary. About three weeks after hiving, the first brood will start batcbiog. By that time many of tbe bees that came with the package will have died. It is an advantage if a frame of brood, with young bees clinging to it, can be put into the hive two weeks after tbe package was bived. The youog bees emergiog from this frame help the colony to build up very rapidly.

NUCLEI AND STOCKS

Hives can be stocked by buying nuclei or stocks of bees. A nucleus is a small colony composed of four or six frames of brood and food with all frames well-covered with workers. A stock is composed of eight to eleven frames of brood, food and bees. A nucleus or stock is shipped in a ventilated travelling-case having wire gauze at the top and sides. Care must be taken when ordering nuclei or stocks to state whether tbey are wanted on Modified Dadaot or on Langstroth brood frames.

in the frame hive, cut out the combs. Cut the hrood comh to fit in the empty frames, tie it in with string or tape, and put tbem into the hive. Also tie in some honeycomb and put that in too. The rest of tbe comb put into a tin with a lid to prevent robhing. Sbake or brusb in any clusters of bees, replace the covers and staple the floor board in position, but do not put in the entrance hlock. Take the frame bive to the foot of tbe tree in which tbe primitive hive bad been hanging. Secure the rope to tbe hive using crate staples to ensure tbat the rope or wire will not slip. Hoist tbe hive clear of the ground, and make sure tbat it is hanging level in tbe rope sling. Then boist the frame hive up into the tree as near as possible to tbe former position of the primitive hive. Secure tbe rope in sucb a manner tbat the hive can be lowered easily without jarring it.

Leave tbe hive hanging in the tree for a day or two, to give the hees a chance to settle down, and to secure the comhs in tbe frames. After a day or two, late in the evening, when all the bees are in the hive, carefully lower it, and quickly slip in the entrance closing hlock. Then take the hive off to an apiary site at least two miles away. If there is no honeyflow, feed the bees. If they take down their food readily, and if pollen is being brought into the hive, you may he pretty sure that all is well and they are going to stay.

It may bappen that the queen gets killed during the transferring, hut so long as tbere are eggs or young brood present in the bive, the hees can raise a new queen. Tbere is a danger of the hees absconding wben the virgin goes out to mate. If you have a spare frame or two of young hrood tbat can be taken from another hive and put in the hive containing tbe virgin, it is unlikely tbat tbey will ahscond, as bees rarely desert young hrood.

PACKAGE DEES

In some parts of tbe world, package bees are used extensively for stocking empty hives. Package bees are an artificial swarm sold in a container baving wire gauze sides. The queen travels with the bees but in a mailing cage. Provision is made for feeding the bees in the package. Sometimes a feeder containing sugar syrup is used, at other times the food consists of a cake of candy. The size of the package is two or three pounds of bees, that is, eight or twelve thousand bees.

A great advantage of package bees is that, being combless, the danger of transmitting brood disease is negligible. Honey should not be used in the food which travels with the bees as the spores of foul brood can be transmitted in boney.

As soon as tbe packages are received, spray the wire cloth sides

of the containers with sugar syrup and store the packages in a cool dark place. Make sure that the hives are ready to receive the bees. There should be five frames in the hive, preferably containing drawn combs with pollen, otherwise with full sheets of foundation. Push the frames over to one side of the hive. Put the entrance block in so that there is only a small entrance. Pack the entrance lightly with grass to stop the bees from rushing out straight away; the next day they will be able to work their way through the grass and in time they will remove it. Have a full feed can ready for each hive and an empty super to put round the can.

At dusk, hive the packages. First feed the bees by spraying the sides of the packages with sugar syrup. When they have taken all the syrup they want, shake them down to the bottom of the package and spray them with water to stop them from flying. Take the feeder and the queen cage out of the package. If there is drawn comb in the hive, remove the cover from the open end of the queen cage and place it on the floor of the hive, wire gauze side up, and under the frames. If there is only foundation, remove the cover from the candy and scoop out sufficient candy so that there is only just enough to keep the queen in for a few minutes. Shake a few bees into the hive on top of the queen cage and then place the package in the hive with the feed hole uppermost. Put on the inner cover and put the feed can over the hole in the cover. Place the empty super round the feed can and put the roof on.

Two days later, remove the package container and fill up the hive with frames. Leave the bees alone for two weeks but refill the feeder as often as necessary. About three weeks after hiving, the first brood will start hatching. By that time many of the bees that came with the package will have died. It is an advantage if a frame of brood, with young bees clinging to it, can be put into the hive two weeks after the package was hived. The young bees emerging from this frame help the colony to build up very rapidly.

NUCLEI AND STOCKS

Hives can be stocked by buying nuclei or stocks of bees. A nucleus is a small colony composed of four or six frames of brood and food with all frames well-covered with workers. A stock is composed of eight to eleven frames of brood, food and bees. A nucleus or stock is shipped in a ventilated travelling-case having wire gauze at the top and sides. Care must be taken when ordering nuclei or stocks to state whether they are wanted on Modified Dadant or on Langstroth brood frames.

of tbe containers with sugar syrup and store the packages in a cool dark place. Make sure that the hives are ready to receive the bees. There should be five frames in the hive, preferably containing drawn combs with pollen, otherwise with full sheets of foundatioo. Push the frames over to one side of the hive. Put the entrance block in so that there is only a small entrance. Pack the entrance lightly witb grass to stop tbe bees from rushing out straight away; the next day they will be able to work their way through the grass and in time they will remove it. Have a full feed can ready for eacb hive and an empty super to put round the can.

At dusk, hive the packages. First feed the bees by spraying the sides of the packages with sugar syrup. When they bave taken all the syrup they want, shake them down to the bottom of the package and spray them with water to stop them from flying. Take tbe feeder and the queen cage out of the package. If there is drawn comb in the bive, remove the cover from the open eod of the queen cage aod place it on the floor of the hive, wire gauze side up, and under the frames. If there is only foundatioo, remove the cover from the candy and scoop out sufficieot candy so that there is only just enougb to keep tbe queen in for a few mioutes. Sbake a few bees into the hive on top of tbe queen cage and theo place the package in the hive with the feed hole uppermost. Put on the inner cover aod put tbe feed can over the hole in the cover. Place the empty super round the feed can and put the roof on.

Two days later, remove the package contaioer and fill up tbe hive with frames. Leave the bees alone for two weeks but refill the feeder as often as necessary. About three weeks after hiving, the first brood will start hatchiog. By that time many of the bees that came with the package will have died. It is an advantage if a frame of hrood, with young bees clinging to it, can be put into the hive two weeks after the package was hived. The young bees emergiog from this frame help the colony to huild up very rapidly.

NUCLEI AND STOCKS

Hives can he stocked hy huyiog nuclei or stocks of hees. A nucleus is a small colony composed of four or six frames of brood and food with all frames well-covered with workers. A stock is composed of eigbt to eleven frames of brood, food and hees. A nucleus or stock is shipped in a ventilated travelling-case haviog wire gauze at the top and sides. Care must he taken when ordering nuclei or stocks to state whether they are wanted on Modified Dadant or on Langstroth hrood frames.

in the frame hive, cut out the combs. Cut the brood comb to fit in the empty frames, tie it in with string or tape, and put them into the hive. Also tie in some honeycomb and put that in too. The rest of the comb put into a tin with a lid to prevent robbing. Shake or brush in any clusters of bees, replace the covers and staple the floor board in position, but do not put in the entrance block. Take the frame hive to the foot of the tree in which the primitive hive had been hanging. Secure the rope to the hive using crate staples to ensure that the rope or wire will not slip. Hoist the hive clear of the ground, and make sure that it is hanging level in the rope sling. Then hoist the frame hive up into the tree as near as possible to the former position of the primitive hive. Secure the rope in such a manner that the hive can be lowered easily without jarring it.

Leave the hive hanging in the tree for a day or two, to give the bees a chance to settle down, and to secure the combs in the frames. After a day or two, late in the evening, when all the bees are in the hive, carefully lower it, and quickly slip in the entrance closing block. Then take the hive off to an apiary site at least two miles away. If there is no honeyflow, feed the bees. If they take down their food readily, and if pollen is being brought into the hive, you may be pretty sure that all is well and they are going to stay.

It may happen that the queen gets killed during the transferring, but so long as there are eggs or young brood present in the hive, the bees can raise a new queen. There is a danger of the bees absconding when the virgin goes out to mate. If you have a spare frame or two of young brood that can be taken from another hive and put in the hive containing the virgin, it is unlikely that they will abscond, as bees rarely desert young brood.

of the containers with sugar syrup and store the packages in a cool dark place. Make sure that the hives are ready to receive the bees. There should be five frames in the hive, preferably containing drawn combs with pollen, otherwise with full sheets of foundation. Push the frames over to one side of the hive. Put the entrance block in so that there is only a small entrance. Pack the entrance lightly with grass to stop the bees from rushing out straight away; the next day they will be able to work their way through the grass and in time they will remove it. Have a full feed can ready for each hive and an empty super to put round the can.

At dusk, hive the packages. First feed the bees by spraying the sides of the packages with sugar syrup. When they have taken all the syrup they want, shake them down to the bottom of the package and spray them with water to stop them from flying. Take the feeder and the queen cage out of the package. If there is drawn comb in the hive, remove the cover from the open end of the queen cage and place it on the floor of the hive, wire gauze side up, and under the frames. If there is only foundation, remove the cover from the candy and scoop out sufficient candy so that there is only just enough to keep the queen in for a few minutes. Shake a few bees into the hive on top of the queen cage and then place the package in the hive with the feed hole uppermost. Put on the inner cover and put the feed can over the hole in the cover. Place the empty super round the feed can and put the roof on.

Two days later, remove the package container and fill up the hive with frames. Leave the bees alone for two weeks but refill the feeder as often as necessary. About three weeks after hiving, the first brood will start hatching. By that time many of the bees that came with the package will have died. It is an advantage if a frame of brood, with young bees clinging to it, can be put into the hive two weeks after the package was hived. The young bees emerging from this frame help the colony to build up very rapidly.

NUCLEI AND STOCKS

Hives can be stocked by buying nuclei or stocks of bees. A nucleus is a small colony composed of four or six frames of brood and food with all frames well-covered with workers. A stock is composed of eight to eleven frames of brood, food and bees. A nucleus or stock is shipped in a ventilated travelling-case having wire gauze at the top and sides. Care must be taken when ordering nuclei or stocks to state whether they are wanted on Modified Dadant or on Langstroth brood frames.

When the nuclei or stocks are received, spray the screens with sugar syrup and store in a cool dark room until dusk, as with packages. At dusk the hees should he sprayed with water, the travelling-case unfastened, and the frames placed in the hive. Any bees remaining in the case are shaken in. The inner cover is put on and the hees should be fed. Put grass in the entrance to impede the passage of the hees for a few hours.

Once you have hees estahlished in some hives, additional hives can be stocked hy making increase (Chapter XV) or with artificial swarms (Chapter XVI).

Chapter XV

MANAGEMENT OF FRAME HIVES

Controlling Bees—Opening a Hive—Inspecting Hives—Feeding Bees—Uniting Bees—Brood Nest Management—Modified Dadant Single Brood Box Management—Langstroth Double Brood Box Manogement—Relocotion—Supering—Using Queen Excluders—Removing the Supers—Moving Bees—Migrotory Beekeeping—Making Increase—Use of Bees for Pollination.

THE modern frame hive has been evolved during the past hundred years into a highly efficieot implement. This is true of the patterns used by commercial heekeepers. The faney hives, used by many other people in some tropical eountries as well as in Europe, are entertaining and picturesque hut are not efficient. A frame hive, by comparison with a simple hive, is expensive; hut so is a tractor and its eultivating implements when compared with a simple hoe. It is the financial return in the hands of a eompetent operator that justifies the expenditure. Competent operation is the factor which counts. For a frame hive to justify its eost it must he managed eompetently. There are vast numhers of frame hives in the hands of heekeepers in all parts of the world which are not properly managed, if they are managed at all. In the hands of such heekeepers, frame hives are merely a waste of money, and the results obtained could he got just as well witb the use of simple hives.

In this and subsequent chapters I will endeavour to set out methods of management and details of operations with frame hives whicb, if applied intelligently in eonjunctioo with study of local cooditions of climate and vegetation, will eoable the user of frame bives to obtain the best possible return from his bees.

CONTROLLING DEES

The first essential of hive management is to get the bees uoder control. If the bees are belligerent, proper management is impossible. From the moment tbe hive is approached, the bees must be got under control and kept that way every moment of the time until the operation is completed aod the hive elosed up. The bees are kept under control by intelligence, confidence, gentleness aod some smoke.

Where bees kept in the open are impossible to control for full management, they should be kept in a bee house as described in Chapter VIII.

The bees can sense at once if a beekeeper is nervous. A nervous person apparently gives off some odour that all animals and bees can detect and to which they react adversely. Complete self-confidence is essential in a beekeeper. That is achieved by knowing that even if the bees do attack they cannot hurt you. There are a few people among all races who can handle bees of all kinds without any protection whatsoever, and are never stung. The majority of people are well advised to protect themselves as completely as possible from getting stung. A good bee veil is necessary. Some people prefer to work with bees with their hands bare, but with their sleeves fastened so that the bees cannot climb up them. Commercial beekeepers, who are handling bees all day long during the season, often wear bee gloves to protect their hands from propolis as much as to protect them from unnecessary stings. Once you have got used to wearing a good type of bee glove, you can handle hives and frames almost as gently with them as without. When actually handling the bees themselves, as when working in a queen-raising apiary, a more delicate touch is required, and gloves are not worn. Before starting work with the bees, make sure that your bee veil and clothing are properly adjusted. That helps towards self-confidence.

Before touching a hive, ensure that the smoker is well alight and working properly. Start the smoker off with a piece of wood wool or straw and get it burning freely, then put in a roll of smoker fuel. Every beekeeper has his own preference for a particular fuel. I like old sacking cut into strips about six inches wide and rolled. What is required is lots of cool smoke, and no flames or red-hot sparks which only infuriate the bees. Smoking should be done gently and lightly, just sufficient to keep the bees under control and no more.

All movements when working around hives should be slow and deliberate. Rapid and nervous movements annoy the bees. Steady, deliberate, confident movements are needed. But do not dawdle. Get on with the job with a steady inevitability. Open the hives without a jerk. Separate and remove frames firmly but without crushing or rolling a single bee. Do not breathe on the bees. Replace the frames in the same way and close up the hive without a knock. If you hurt one bee in the hive, it will enrage others. If one bee stings you or your clothing, others will sting the same place. Use your smoke for controlling the bees, not for blasting them.

OPENING A HIVE

Always approach a hive from the rear or side, never from the front, and never stand in front. Work standing at one side or the other. Blow smoke gently into the entrance of the hive. If you have reason to believe that the bees might be inclined to be cross, close the entrance gently without crushing any bees. Remove the roof, insert the flat end of the hive tool under the inner cover and prise it up, blowing smoke in under the cover. Wait a moment or two, then remove the cover, glancing at it to see if the queen is on it before putting it down. Blow some more smoke across the tops of the frames to keep the bees down. Using the hive tool, separate the outside frame nearest you and lift it straight out without crushing or rolling any bees. Stand the frame on end resting against the hive or hive stand. Blow some more smoke lightly across the tops of the frames before proceeding with the inspection.

Return the frames and close up the hive in the same gentle manner, and do not crush any bees. Make sure that the frames are pushed well together, they will then be easier to remove next time. Nothing angers a colony more than a jolt to a frame. If the frames have been properly assembled and fit correctly in the hive, they can be separated and removed without any jarring. One of the most difficult hives I have ever had to handle was one that had been home-made. The frames were a bad fit and incorrectly nailed. Some of the foundation had slipped out of position in the frames through being wrongly fitted, and as a result, the bees had built comb all over the place. To separate the combs was a frightful job. Comb had to be cut almost every time. It was a classic example of the results of bad manufacture and assembly of hives.

INSPECTING HIVES

Bees should be disturbed as little as possible. It is, however, necessary to inspect the hive occasionally to check up on the queen, to see that the bees have sufficient room and to control swarming. The first inspection of the season should be a thorough one and should be carried out at the beginning of the build-up period, when the bees have started breeding again after a period of dearth.

At this first inspection each comb should be checked. Any combs which have more than a few drone cells should be removed and replaced by full sheets of foundation. If defective combs contain brood, they should not be removed but should be moved to the outside of the brood nest nearest the side of the hive. Defective combs

containing honey should be placed on the outside so that they can be removed later, when empty.

It is not necessary to try to find the queen. The presence of healthy worker brood in all stages of development shows that all is well with the queen. See that there is plenty of honey stored in the combs, and if not, feed the bees, or better still, if it can be managed, give them a comb or two of honey from a hive which has an abundance.

It is neither necessary nor desirable to take out all the combs in subsequent inspections. All that is required in checking up on the queen is to glance down between the frames to see where the main mass of bees is clustering. A comb is taken out of the middle of the cluster and, if all is well, it will contain worker brood, probably in all stages of development. By looking down between the combs on each side of the brood nest it is possible to see how many combs the bees are using, and the sight of the cappings of sealed honey on the outer combs will indicate the food position.

During the honeyflow the only inspection that is normally required is to check on whether the bees have sufficient room to store the crop. It is not necessary to remove any frames to do this. A puff of smoke over the frames to keep the bees down will enable the beekeeper to see how many combs are being used and so enable him to judge whether another super is required.

Inspections undertaken in the course of swarm control measures are dealt with in Chapter XVI.

FEEDING BEES

Bees need feeding on few occasions. In temperate climates bees are fed after the honey crop has been removed in the autumn in order to ensure that the bees have enough food to live on during the winter. Bees are also fed in the spring if they look as though they are going to run short of stores before the honeyflow starts. They are also fed when it is necessary to stimulate breeding.

Freshly hived swarms, or transferred colonies, should be fed as much sugar syrup as they will take in order to give them a chance to establish themselves in their new quarters. This feeding enables the bees to build comb rapidly and start breeding. If a swarm does not get a good start it will dwindle rapidly and then have difficulty in recovering. Feeding should never be half-hearted. Twenty pounds of sugar syrup is the minimum which should be given to a newly hived swarm.

The easiest way of preparing food for the bees is to fill a tin seven-eighths with white refined sugar. Then, stirring all the time,

pour in boiling water till the tin is filled right up. Continue stirring until all the sugar is dissolved. Alternatively, if you are going to make up large quantities, boil up the water in a suitable vessel and then add an equal quantity by volume of sugar, that is, to each gallon of water add one gallon of sugar. Stir until all the sugar is dissolved and feed to the bees when the syrup has cooled.

The best feeder is a lever lid tin, such as a seven-pound honey tin. Punch a number of small holes in the lid with the point of a sharp nail, fill the tin with syrup, press the lid on tightly and turn the tin upside down. At first a little syrup will run out but then the air pressure will be sufficient to keep the rest in. Place an inner cover with an escape hole over the brood box and put the tin over the hole. The bees can then come up through the hole in the inner cover and take down the syrup from the minute holes in the lid. Put an empty super round the tin and place the roof on top.

Should there be a shortage of pollen during the period when the colonies should be building up, breeding will decrease and result in the colonies being weaker than they should be at the time of the honeyflow. In order to maintain breeding during a dearth of pollen, the bees can be fed with pollen substitute. This is prepared by mixing one part of yeast, either brewers' or bakers', with two parts by weight of soy bean flour. Moisten the mixture with sugar syrup and knead into a soft paste. Place a flat cake of this mixture directly on top of the frames in the brood box and replace the inner cover upside down. Renew the pollen substitute after ten days if there is still a shortage of pollen.

UNITING BEES

Sometimes it is necessary to unite two or more colonies of bees. If a colony is too weak to be able to build up by itself it is not worth keeping it and wasting sugar syrup trying to feed it. It is best to join it up with another colony.

The simplest and most efficient way of uniting two stocks is to place a sheet of newspaper over the stronger colony and prick a few small holes in the paper. Remove the floorboard from the weaker colony and put the brood box on top of the newspaper. The bees on both sides will start to chew away the paper and by the time they have met they will unite peaceably. The bees or the queens themselves will sort out which queen will survive. Alternatively, the beekeeper can remove the poorer queen before uniting.

In the same way a swarm can be united to a colony. In this case, an empty brood box or super is put on top of the newspaper and the swarm dumped into it, and the lid put on quickly.

BROOD NEST MANAGEMENT

The object of brood nest management is to get the maximum development of the colony during the eight weeks before the beginning of the honeyflow, in order that the colony will have tbe strongest possible force of flying bees to cnllect the crop.

Brood nest management involves regular inspection during the build-up period to ensure that (*a*) the queen is laying well; (*b*) there is adequate room for the expansion of the brood nest; and (*c*) there are ample stores of fond in the hive. In addition, imperfect combs are replaced with frames of foundation and a constant watch is kept for pests and the symptoms of disease.

In the Modified Dadant hive the brood nest is contained on eleven frames in one brood box. Thus inspections and manipulations are easy and simple to do efficiently. However, witb tbe Langstrotb hive, if tbe queen is as prolific as a good queen sbould be, two brood boxes will be needed, resulting in the brond nest being spread over twenty frames in two separate boxes. I have used both systems and my experience is that the double brood cbamber system is a lot more work, much more difficult to manage properly and it does not produce any more honey. Further, the brood nest development on the large M.D. frames takes place more smoothly than on the smaller Langstroth frames, and under mnre natural conditions. In addition, it is easier to assess the characteristics of a queen in M.D. hives than in Langstroth hives, and this is of vital importance in selecting the best strains for breeding.

MODIFIED DADANT SINGLE BROOD BOX MANAGEMENT

About eight weeks befnre tbe honeyflow is expected to start, the brood nest should have begun to expand. At this time the hive is inspected and an empty comb put at one side of the brood nest, between tbe outermost comb of the brood nest and tbe comb of pollen and honey. Do nnt put empty combs between the combs of brood. As soon as the strength of the colony is such that the bees are able to cover the additinnal brood, the queen will lay in the empty comb.

Make sure that there is plenty of food. There should be at least two brood frames full of honey and pollen. If there are less than two frames of food, or if no nectar is coming in, start feeding. If there is plenty of honey but no pollen, feed pollen substitute.

A week or ten days later, if the comb has been filled with brood, another empty comb is put between tbe brood nest and the food

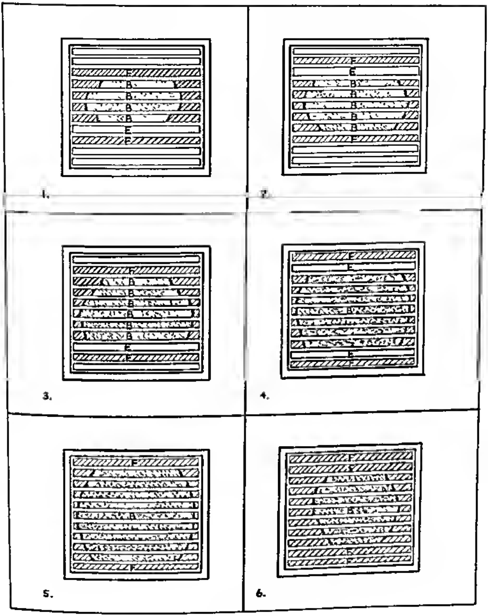


FIG. 27

BROOD NEST MANAGEMENT, SINGLE BROOD BOX

1. Eight weeks before the honeyflow, an empty comb is put next to the outside brood comb.
2. Spreading again, ten days later.
3. Spreading after a further ten days.
4. Spreading both sides of the brood nest. Only two combs remain to be filled—Give a super.
5. During the three weeks before the honeyflow, brood nest develops to full size giving maximum production of workers.
6. During the honeyflow, brood nest contracting, food being stored in the brood box.

comb. This may be done on the same side of the brood nest as before or on the other side. This is repeated every week or ten days until there are seven frames of brood. Then two empty frames are put in, one on each side of the brood nest, the two remaining frames on the outside being full of honey and pollen. Never let the food supplies drop below two full frames; feed whenever necessary.

After the last adjustment to the brood nest, as there are only two frames remaining to be filled in the brood box, put on a super to give space for the ripening and storing of honey.

LANGSTROTH DOUBLE BROOD BOX MANAGEMENT

When the colony is covering eight combs in a Langstroth brood box, a second brood box containing combs is placed on top. Make sure that the colony has plenty of stores and if it has not, feed.

If no combs are available, the second box will contain full sheets of foundation. In this case, take two frames of brood and bees out of the colony and place them in the second box. Put the two frames of foundation from the second box into the lower box outside the occupied frames. Place the second box with the two frames of brood and bees on top of the colony, and if no nectar or pollen is available, feed. This doubling stimulates the development of the brood nest and should be carried out eight weeks before the beginning of the honeyflow.

If the colony is not up to strength for doubling eight weeks before the beginning of the flow, the second brood box must be given no later than six weeks before the flow is expected to start. Colonies which are not ready for it then are not likely to be honey-producing stocks but will be able to build up to strength on the honeyflow.

If the colony has had two brood chambers during the period of dearth, it may be found that during the build-up period most of the brood is in the upper box. If this is the case, the position of the boxes should be reversed, the upper box being placed on the floor board, and the lower box, which is nearly empty, placed in the upper position. This has the same effect as doubling and should be done eight weeks before the honeyflow. It should not be necessary to feed a colony that was left with a full brood box of honey at the end of the last honeyflow.

About one week before the honeyflow, or, if the honeyflow lasts longer than four weeks, when the honeyflow begins, the queen is confined to the lower brood box. This is done by examining the combs, finding the queen and putting her in the bottom box. A queen excluder is put over the bottom box and the upper box placed over

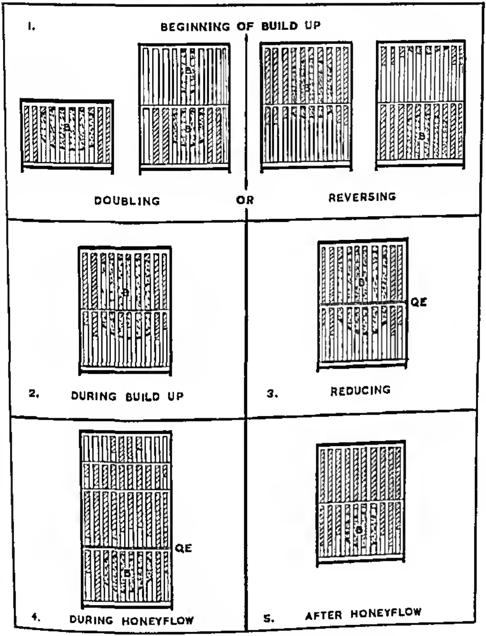


FIG. 28

BROOD NEST MANAGEMENT, DOUBLE BROOD BOX

the queen excluder. The queen is thus restricted in her egg laying at the time when all effort is required on honey production. The upper brood box will be filled with honey, and this will be left on the hive to be the colony's food store for the next period of dearth and build-up period. Supers are given as required.

RELOCATION

Some books recommend that the positions of strong and weak colonies should be interchanged during the build-up period. The idea behind this is that the weak colonies are reinforced by the flying bees of the strong colonies, and the strong colonies are held back from developing too rapidly. However, this practice has some serious disadvantages. If the bees are good defenders of their hives, a quality important in the tropics, heavy losses from fighting may result. It may be that the weak colonies are weak because of incipient disease, in which case, interchanging them with strong colonies will spread the disease. Finally, the performance of the different strains is masked, so it is not possible to judge which are the best strains of bees from which to breed. Therefore, I do not recommend the practice of interchanging the positions of hives, or relocation as it is sometimes called.

SUPERING

The honey and beeswax crop is obtained by putting boxes of frames, usually shallow, on top of the brood box. These are termed supers. In a wild colony the honey is stored over the brood so the presence of a vacant space above the brood nest stimulates the bees to fill it with honeycomb.

Put the supers on before the bees really begin to feel the need for extra space. If you wait until the bees have filled up the brood box completely before giving a super, not only will you lose some of the crop but you may have caused the bees to start swarming preparations, with the resulting misdirection of effort. Remember that not only do the bees need room for storing honey, but they also need a lot of room for ripening it. So, as soon as the bees are starting to work in the last two vacant frames in the brood chamber put a super on the hive.

The first super you give should contain drawn comb, but if you only have foundation, put it straight on top of the brood box and leave it like that until the bees have started work in the super. Once the bees are storing honey in the super, put the queen excluder between the super and the brood chamber. When you do this, have

a look at the centre frames in the super to make sure that the queen has not gone up into it and started laying eggs. If she has, find her and put her below the excluder.

If you are using two brood boxes and already have the queen confined below in the bottom box, you will not require a queen excluder directly under the super.

Give additional supers as required, ahead of the bees' requirements. When the top super is three-quarters full, that is the time to give another super. Delay in giving supers means a loss of crop which the bees could have gathered had they had the room in which to store it. Always put the additional super on top of the last one.

USING QUEEN EXCLUDERS

There are two schools of thought as to whether or not queen excluders should be used. Some claim that a barrier of honey at the top of the brood combs keeps the queen in the brood chamber, but with good queens you often find brood filling the brood frames right to the top bar. Personally, I would not be without excluders on all supered hives. It is most annoying to have to look through two or three supers of honey to try to find the queen when wanting to take the supers away for extracting. Not only does one waste a great deal of valuable time, but also one runs the risk of thoroughly upsetting the bees which are always rather touchy at the end of the honeyflow. It is altogether poor economy to try to do without queen excluders. The queen excluder not only keeps the queen below in her proper place, the brood box, but it also helps to keep pollen out of the supers. The place for pollen is next to the brood in the brood box, and not mixed up with the honey in the supers. But remember to let the bees become accustomed to working in the first super before putting the queen excluder under it.

REMOVING THE SUPERS

A super can be taken off the hive as soon as the honey in it has been ripened. Once they have completed the task of ripening the honey, the bees seal the cells over with wax caps. When the main mass of the honey has been sealed over in this manner, it is safe to take it off. It does no harm to leave the honey on the hive after it has been ripened. In fact, some beekeepers leave the honey on until the end of the honeyflow and then take off all the supers together. If the flow is a very heavy one, it may be necessary to take off the

supers as soon as they are filled, in order to extract the honey and return them to the hive ready to receive the rest of the crop.

To remove the honey, place the super which is ready on top of the hive. Under the super put an inner cover with a Porter bee-escape in the hole. Leave it on for two days, by which time most of the bees will have gone down through the escape, and as they are unable to return, the super will be reasonably free of bees. All that has to be done then is to lift off the super, shake or smoke out any bees that remain and take away the super for extracting.

Many commercial beekeepers use acid boards for clearing the bees out of the supers. This method is quick and usually efficient, but has to be used with care. There is a danger of tainting the honey, of killing the brood and of driving the bees completely out of the hive if the acid board is left on too long.

The acid board consists of a metal sheet the size of the top of the hive fitted with a piece of cloth tacked in position with a wooden rim all round. An inner cover can be adapted for this purpose. The cloth is dampened by sprinkling it with a solution of carbolic acid, made up by dissolving chemically pure carbolic acid crystals in an equal quantity of warm water. Great care must be taken in handling this carbolic acid as it will burn the skin.

To clear the supers, the roof and inner cover are removed, and the acid board is placed on top of the supers, damp cloth side down. In warm weather, the bees will leave the top super in about five minutes, so while waiting, other boards can be put on other hives. The great advantage of the acid board method is that the supers can be removed at one visit to the apiary; the bee-escape method requires two visits.

Do not leave any supers about uncovered, even for a few minutes, otherwise the bees will find them and in no time you will have the bees in an uproar, robbing. After the supers have been taken off, make quite sure that the roofs have been put on properly so that bees intent on robbing cannot get into the hives. Also see that the hive entrances are of such a size that the bees can guard them against intruders.

MOVING BEES

Bees that have gone out foraging always return to the place where the hive was when they left. Also, if the hive is moved a small distance the bees fly straight out and come back to the place where the hive used to stand. If the hive is moved only a couple of feet then that does not matter, as the bees, on finding their hive gone, search around until they find it. If the hive is moved more than a few feet,

the bees will eome back to the original spot and many will not find the hive again. They will form a cluster on the hive stand. If, however, the hive is moved more than one mile, the hees will fix their new position and come hack to the hive on its new stand.

If it becomes necessary to move the hive more than a couple of feet and less than a mile, it is necessary to make the hees realize that they have heen moved. This can be done hy impeding their passage through the entrance hy stuffing grass into it lightly so that the hees have to struggle through it to get out. Another method is to lean a piece of glass against the front of the hive. That stops the hees from flying straight out and gives them cause to reorientate themselves.

When moving a hive by road any distance at all, tbe hive must he properly prepared. A day or two heforehand a travelling screen is put on tbe hive directly over the brood box or the top super and the eover put on over it. The travelling sereen consists of a frame the same size as tbe hive and at least one incb deep. On the frame is seeured wire gauze of ten or twelve wires to the inch. The travelling screen is either serewed or stapled on to the hive. All parts of the hive, floor board, hrood box, or hrood hoxes, and supers if any, are firmly stapled together with two-ineh erate staples or fixed witb lock slides or wedge elips. Some migratory beekeepers also strap the parts of the hive together with half-inch steel tape. This is an exeellent idea and makes a good sound joh of tbe hive, and eertainly should he used if the hives will be handled hy strangers or paid help.

The last thing to do hefore the hive is moved is to elose the entrance and remove the cover from the travelling screen. The elosing of the entrance sbould be done at night when all the hees are in the hive. The hees so seeured must he shaded at all times. The hives must not be left standing in the sun or the bees will hecome overheated and heavy casualties will he caused.

Pack hives on a vehicle with the frames running fore and aft, and not across the vehicle. The hives must he packed tightly so that they will not move. When more than one layer of hives is packed on to a truck, pieces of timber must be placed hetween the layers so that there is free circulation of air over the travelling screens. Rope the load securely.

If the hees are to he moved only a short distance, twenty or thirty miles, this can he done in the cool of the early morning. In such a case the hives are shut up at least one hour hefore the first light of dawn, when the hees are clustering closest in the hive. Then load and move straight away. If long journeys are to be undertaken, the bees should he shut up as soon as possible after dark and the journey done hy night. If the trip will take more than one night, a halt

should be made soon after dawn, the hives unloaded and scattered about and the bees allowed to fly. Water should be made available for the bees. After nightfall, the entrances are closed again, the hives reloaded and the journey resumed. It may seem a lot of extra work to unload and reload the hives each day but it is well worth it in the number of bees that are saved. However, such long journeys would be the exception rather than the rule even for the most ardent of migratory beekeepers.

MIGRATORY BEEKEEPING

Migratory beekeeping is the most intensive of all forms of honey production. The beekeeper moves his bees round the country from honey crop to honey crop. As soon as the honeyflow has stopped in one place and the beekeeper has extracted the crop, he packs up the hives on his lorry and moves to another climatic zone or vegetation type where another honeyflow is just starting. By careful study of the vegetation and climate and the resultant honeyflows in different regions, the migratory beekeeper can collect crop after crop, in some countries almost the whole year round. In this way the beekeeper is getting the greatest production from his hives.

MAKING INCREASE

In addition to the methods of stocking hives already mentioned in Chapter XIV, namely, by hiving swarms, transferring wild colonies or by the purchase of package bees, nuclei or stocks, the beekeeper can make increase by using the colonies he has already.

The first necessity is to have a supply of young queens. These may be bought or raised by the beekeeper himself. In Chapter XVII are described the methods of queen raising.

Increase can be made either at the beginning of the honeyflow period or later in the season when the peak of the honeyflow is passed.

At the beginning of the season nuclei are made, each consisting of two frames of brood and at least one frame of food. A young queen is introduced to each nucleus. These nuclei are made at the expense of the strength of the original stock.

The procedure is as follows. For preference, set up your hives to be stocked with nuclei in another apiary at least a couple of miles away. When the stock to be split is really strong in brood, take it to the nucleus apiary and divide it up, giving two frames of brood to each nucleus. Keep a look-out for the queen of the original stock

and leave her in her own hive. Introduce a young queen to each of the new nuclei in a simple introducing cage. Take the original hive, which now contains only a nucleus and the old queen, back to its own apiary. Feed all the nuclei for a while to enable them to build up.

Towards the end of the season when there will not be time for nuclei to build up to strength before the period of dearth, it is necessary to make up full stocks. From each of three strong stocks take two frames of brood with attached bees, making sure that the queen is left behind. Thus you have a colony of six frames of brood. Give them a young queen and they will build up nicely.

With the first method, if your stocks have eight frames of brood, you will be able to divide them into four, thus multiplying your number of stocks by four at the expense of the honey crop. With the second method, you get your honey crop from the original stocks, and make one additional colony from three old ones.

Another method of making increase is used in conjunction with swarm control. This is making a shaken swarm. The technique is described in the next chapter.

USE OF BEES FOR POLLINATION

Many fruit and seed crops need the services of bees to ensure adequate pollination for the production of the maximum possible crop. To be effective for pollination purposes the colonies must be producing brood in considerable quantity and so have an urgent need to collect pollen. It is considered that colonies used for pollination should have at least six frames of brood.

The number of colonies necessary to ensure adequate pollination of a given area of crop depends upon the numbers of flowers in the area and this is a very variable factor. The usual estimate is about one colony per acre, but this may be insufficient. Lucerne (Alfalfa) requires five hives to each acre, and replacement of the hives with fresh colonies every week, in order to get maximum seed production. Experiments are required in each case to determine the optimum number of colonies to be used for a given crop in a given area. Also much depends upon the strength of the colonies of bees.

In some countries the grower of the crop hires colonies from a beekeeper. The number of colonies and the size of them is agreed, together with the dates when the hives will be brought in and when they will be taken away again. This is most important, not only from the point of view of ensuring that the bees are present when the flowers are at the best stage for pollination, but also so that any

necessary spraying or dusting with insecticides can be done before or after flowering when the bees are not present.

The hives should be located in groups in the area where the crop is grown. This is convenient both for the handling and management of the hives as well as from the point of view of the grower. Research has shown that grouping results in more efficient pollination (1).

In some areas in the tropics, particularly where there is a danger from thieves, ratels or martens, or where the bees are regularly required, or owned by the grower of the crop, bee houses are recommended.

Bees visit the flowers having the greatest concentration of sugar in the nectar and more or less ignore those with a lower sugar content. It sometimes happens that in an area where a crop is grown which needs pollination, there are other flowers containing more attractive nectar. As has been shown earlier, bees recruited to foraging search in the area indicated for flowers having the same smell as that which was circulated in the hive by the bees that found the source. So, in an endeavour to ensure that the bees will visit the flowers which are to be pollinated, some beekeepers feed the colonies with a strong sugar syrup in which flowers of the crop have been steeped. This feeding with scented sugar syrup is done in the hive in the normal way with a lever lid tin over the hole in the inner cover. There have been conflicting reports of the effectiveness of this method of increasing pollination (2). There is room for much more research on this subject, with the use of proper controls and statistical analysis to determine whether the observed differences are in fact significant.

The United States Department of Agriculture has published the following list of fruit and seed crops which benefit from insect pollination (3):

FRUIT CROPS

Almond	Cucumber	Peach
Apple	Dewberry	Pear
Apricot	Gooseberry	Persimmon
Avocado	Grape	Plum and Prune
Blackberry	Huckleberry	Raspberry
Blueberry	Mango	Strawberry
Cherry	Muskmelon	Tung
Cranberry	Nectarine	Watermelon

SEED CROPS

Alfalfa (Lucerne)	Red Clover	Parsnip
Asparagus	Strawberry Clover	Pepper
Broccoli	Sweet Clover	Pumpkin
Brussels Sprouts	White Clover	Radish
Buckwheat	Collards	Rape
Cabbage	Cotton	Rutabaga
Carrot	Cucumber	Squash
Cauliflower	Flax	Sunflower
Celery	Kale	Trefoil
Alsike Clover	Kohlrabi	Turnip
Crimson Clover	Muskmelon	Vetches
Ladino Clover	Onion	Watermelon

Quite a number of the above are grown in the tropics, and some are very important tropical crops.

To this list can be added cashew nut, coconut and pyrethrum, and there are almost certainly other tropical fruit and seed crops which benefit from pollination by honeybees but have not yet been studied from this aspect.

REFERENCES

1. BUTLER, C. G., JEFFREE, E. P. AND KALMUS, H. (1943). 'The behaviour of a population of honeybees on an artificial and on a natural crop.' *Jour. exp. Biol.* 20(1): 65–73.
2. FREE, J. B. (1958). 'Attempts to condition bees to visit selected crops.' *Bee World* 39(9): 221–30.
3. UNITED STATES DEPARTMENT OF AGRICULTURE (1942). *The dependence of agriculture on the beekeeping industry.* U.S.D.A. Circ. E-584.

Chapter XVI

SWARM CONTROL

Swarm Control Inspectians—Clipping the Wings of Queens—Natural Swarms—Checking Swarming—Controlling Swarming—Making an Artificial Swarm—Making a Shaken Swarm—Other Methods of Swarm Control.

SWARMING is the method by whicb bee colonies reproduce themselves. The instinct to reproduce is very strong in all creatures; and once the desire to swarm bas got a bold on a colony of bees, the urge to reproduce must be satisfied or tbe stock will be ruined. Wbat actually impels the colony to make swarming preparations in the first place is not really known, though numerous tbeories bave been advanced as to the probable stimuli.

The most that the beekeeper can do is to pay attention to those factors within his control which might act as stimuli to swarmiog. Large brood boxes sbould be used to give adequate room for egg laying and the storage of pollen and reserves of boney. The combs sbould be as near perfect as possible so tbat tbe maximum area of worker comb is available. If tbere is an empty comb or frame of foundation in the brood box wben an iospection is made, it can be moved in next to the brood nest to provide tbe queen with uninterrupted extra space. There should be abundant ventilation. Once a colony has become strong, the entrance block can be removed altogetber. If tbe entrance is too big the bees will build propolis and they will adjust it to tbeir own needs for ventilation and defence. The hives should be shaded from the full heat of the midday or afternoon sun. Put supers on the bive in advance of requirements. Remember that the bees need more room in wbich to ripen boney than they do to store it. See that the hives are fully protected from ant attack. Finally, remember that queens reared the previous year are less inclined to swarm than older queens.

Thus the first steps in swarm control are:

(*a*) to provide adequate room in tbe hive for brood rearing and honey storage in advance of the bees' requirements;

(*b*) to keep the hive cool by providing shade and sufficient ventilation; and

(*c*) to requeen at least every two years, breeding from the most productive non-swarming strains.

SWARM CONTROL INSPECTIONS

The beekeeper will have to learn by observation in what seasons he can expect swarming preparations to be started in his particular area. Once he has learned that, he will be able to carry out swarm control inspections. Normally swarming occurs at the beginning of the honeyflow period and it is a good thing to inspect all colonies at this time. In some areas of the tropics, there may be another swarming season after the honeyflow.

The inspection can be done very quickly. It is necessary to look at only a few brood frames in each hive. There are various little indications that the beekeeper learns to watch for to tell him what is happening. If foundation is being drawn out, or if the brood nest is expanding on to new combs, then it is unlikely that swarming preparations are taking place. The opportunity should be taken to put an empty comb or frame of foundation next to the brood nest to make sure that the expansion of the brood is not impeded by combs packed solid with honey and pollen. Should it be seen that the brood nest is not expanding, and there are few eggs and young larvae, it is possible that the bees are preparing to swarm. Examine carefully all the brood combs to see if there are any queen cells. If these are found, action will have to be taken.

CLIPPING THE WINGS OF QUEENS

Some beekeepers clip a piece off the end of one of the wings of the queens as soon as they have started to lay. The object of this is to prevent the queen from flying off with a swarm. When a colony makes swarming preparations and as soon as the first queen cell is sealed, the bees may attempt to swarm. The queen with a clipped wing is unable to leave the hive, or if she does she will fall to the ground and be lost, so the bees have to return to the hive. If, however, the colony is not inspected before a virgin emerges, the bees will swarm out with the virgin. Thus the clipping of queens' wings must be accompanied by regular inspections every nine days during the swarming season. The only effect of clipping the wings is to prevent the loss of a prime swarm during the nine days between inspections. It is obvious that while the clipping of queens is an extremely useful procedure when the colonies are inspected regularly, it is dangerous if inspections are likely to be delayed.

Chapter XVI

SWARM CONTROL

Swarm Control Inspections—Clipping the Wings of Queens—Natural Swarms—Checking Swarming—Controlling Swarming—Making an Artificial Swarm—Making a Shaken Swarm—Other Methods of Swarm Control.

SWARMING is the method by which bee colonies reproduce themselves. The instinct to reproduce is very strong in all creatures; and once the desire to swarm has got a hold on a colony of bees, the urge to reproduce must be satisfied or the stock will be ruined. What actually impels the colony to make swarming preparations in the first place is not really known, though numerous theories have been advanced as to the probable stimuli.

The most that the beekeeper can do is to pay attention to those factors within his control which might act as stimuli to swarming. Large brood boxes should be used to give adequate room for egg laying and the storage of pollen and reserves of honey. The combs should be as near perfect as possible so that the maximum area of worker comb is available. If there is an empty comb or frame of foundation in the brood box when an inspection is made, it can be moved in next to the brood nest to provide the queen with uninterrupted extra space. There should be abundant ventilation. Once a colony has become strong, the entrance block can be removed altogether. If the entrance is too big the bees will build propolis and they will adjust it to their own needs for ventilation and defence. The hives should be shaded from the full heat of the midday or afternoon sun. Put supers on the hive in advance of requirements. Remember that the bees need more room in which to ripen honey than they do to store it. See that the hives are fully protected from ant attack. Finally, remember that queens reared the previous year are less inclined to swarm than older queens.

Thus the first steps in swarm control are:

(*a*) to provide adequate room in the hive for brood rearing and honey storage in advance of the bees' requirements;

(*b*) to keep the hive cool by providing shade and sufficient ventilation; and

(*c*) to requeen at least every two years, breeding from the most productive non-swarming strains.

SWARM CONTROL INSPECTIONS

The beekeeper will have to learn by observation in what seasons he can expect swarming preparations to be started in his particular area. Once he has learned that, he will be able to carry out swarm control inspections. Normally swarming occurs at the beginning of the honeyflow period and it is a good thing to inspect all colonies at this time. In some areas of the tropics, there may be another swarming season after the honeyflow.

The inspection can be done very quickly. It is necessary to look at only a few brood frames in each hive. There are various little indications that the beekeeper learns to watch for to tell him what is happening. If foundation is being drawn out, or if the brood nest is expanding on to new combs, then it is unlikely that swarming preparations are taking place. The opportunity should be taken to put an empty comb or frame of foundation next to the brood nest to make sure that the expansion of the brood is not impeded by combs packed solid with honey and pollen. Should it be seen that the brood nest is not expanding, and there are few eggs and young larvae, it is possible that the bees are preparing to swarm. Examine carefully all the brood combs to see if there are any queen cells. If these are found, action will have to be taken.

CLIPPING THE WINGS OF QUEENS

Some beekeepers clip a piece off the end of one of the wings of the queens as soon as they have started to lay. The object of this is to prevent the queen from flying off with a swarm. When a colony makes swarming preparations and as soon as the first queen cell is sealed, the bees may attempt to swarm. The queen with a clipped wing is unable to leave the hive, or if she does she will fall to the ground and be lost, so the bees have to return to the hive. If, however, the colony is not inspected before a virgin emerges, the bees will swarm out with the virgin. Thus the clipping of queens' wings must be accompanied by regular inspections every nine days during the swarming season. The only effect of clipping the wings is to prevent the loss of a prime swarm during the nine days between inspections. It is obvious that while the clipping of queens is an extremely useful procedure when the colonies are inspected regularly, it is dangerous if inspections are likely to be delayed.

NATURAL SWARMS

Should a swarm issue from a hive, the parent colony must receive attention in order to stop the emergence of second swarms or casts. If the swarm is found clustering, it is hived as described in Chapter XIV. The parent colony is then examined. There will be at least one queen cell sealed. The best cell should be preserved and all the rest destroyed. Do not shake the frame on which the selected cell has been found for fear of damaging the pupa. Brush off any clusters of bees so that all other cells may be seen and destroyed. The other frames are best shaken to remove the bees to ensure that no cells are missed. Nine days later, inspect the parent colony again. By then the virgin will have emerged from the cell. If there are any other queen cells in the hive, destroy them. Within a few days the virgin should be mated and soon after will start laying.

Should no increase be desired, an alternative method is to hive the swarm into a fresh hive and put it in the position occupied by the parent colony. The parent stock is stood at one side. The swarm will thus be reinforced by all the flying bees. The supers are placed on top of the swarm. The parent colony is dealt with as before and only one queen cell left. Seven or nine days later, inspect the parent colony, check that the virgin has emerged and destroy any other queen cells. Then put the parent colony on another stand at a distance. The swarm will now be further strengthened by flying bees from the parent stock. Later, when the young queen has started laying, the old queen can be killed and the parent colony united up to the swarm.

CHECKING SWARMING

If, in the course of routine inspection, queen cells are found to have nothing more than eggs or very young larvae in them, the cells can be destroyed. Make sure that there is plenty of room in the supers and relieve any congestion in the brood nest. This may result in the bees abandoning swarming preparations.

CONTROLLING SWARMING

If the queen cells have advanced larvae, then the impulse to swarm must be satisfied. Destroying queen cells in this case will not help. If no increase is desired, an artificial swarm is made and left on the site of the original stock. The parent colony is moved to one side. About two weeks later, when the young queen in the parent colony has started to lay, the old queen can be killed and the whole reunited.

When increase is desired, the best method is to make a shaken swarm. The shaken swarm is taken off to another apiary and the parent colony is left on its original stand.

MAKING AN ARTIFICIAL SWARM

You have found queen cells in a colony with advanced larvae in them and you do not want to increase the number of stocks. Take the colony off its stand and place a hive containing frames of foundation in its place. Remove one comb of foundation from the new hive. Turn to the colony and find the queen and put her into the space in the new hive with a frame of brood from which all queen cells have been removed. Put the queen excluder on the new hive, place the supers which were in use over it and put on the cover. The new hive now contains the queen and a frame of brood, and will collect all the flying bees. This constitutes the artificial swarm.

Go through the brood box of the parent colony carefully. Select a frame having the most advanced queen cell and destroy any other queen cells there may be on it. Shake all the other frames and destroy all the queen cells on them. Cover up the hive and stand it to one side. The parent colony now contains the brood less one comb, one queen cell and the young bees. It has no foraging bees as they will all go to the position of their original entrance which is now that of the artificial swarm.

As soon as the young queen has started laying in the parent colony, find and kill the old queen in the artificial swarm and unite the two lots together. It will be found that the artificial swarm will be losing bees as they die off and the brood will not be sufficient to replace them. If the honeyflow is in full swing when the artificial swarm is made it will store quite a lot of honey, but after about three weeks it will be rather weak in foraging bees. By uniting the parent colony to it at that time, it will be brought up to strength by the addition of the bees which have been emerging in the old brood nest.

An alternative method, which saves the use of an extra floor board and stand, is as follows. The queen is placed with a frame of brood in a box of foundation on the original stand and the excluder and supers are placed on top. The original brood box, containing the parent colony, is placed over the supers. All the queen cells are destroyed in the brood frames and seven days later the brood frames in the top box are again examined and any additional queen cells which might have been built are destroyed. When all the brood has emerged from the original brood box it can be removed and the combs used elsewhere. By this method the foraging strength of the colony is maintained.

MAKING A SHAKEN SWARM

When queen cells are present in a colony and increase is desired, a shaken swarm is made. A shaken swarm is composed of bees of all ages and gives a good account of itself.

To hold the swarm, a spare hive is required with a travelling screen. The empty hive is prepared beforehand with five or six frames of foundation in the brood box. A crate staple is driven into the inside of each end of the box to hold the frames against one side of the hive.

The first thing to do is to find the queen. Put her with the frame she is on into the empty brood box, having first destroyed any queen cells on that comb. When looking for the queen it is best to make a mark on the top bar of the frame having the queen cell which is to be preserved.

When shaking the swarm, the travelling screen is held by one person while the other shakes the frames of bees into the box. The operation must be done quickly and the travelling screen kept over the hive except when the bees are actually being shaken in. Rapidly shake in sufficient bees to make a good-sized swarm. Enough bees must be left in the parent colony to cover the brood. Care must be taken not to shake the marked frame having the selected queen cell. When enough bees have been shaken into the hive, the travelling screen is put on and the hive stood in the shade while the parent colony is being given attention. All queen cells other than the selected cell are destroyed in the parent colony and the hive covered. Nine days later check that the virgin has emerged and destroy any other queen cells which may have been built.

As soon as is convenient, the shaken swarm is taken to another apiary and released. The travelling screen is removed and the box filled up with frames of foundation. If the swarm is not taken to another apiary, the flying bees will return to the site of the parent stock, thus upsetting the balance.

OTHER METHODS OF SWARM CONTROL

There are numerous other methods of controlling swarming, but those outlined here are among the best, reasonably simple to use, and have stood the test of time and wide experience. Also, the methods here described require nothing more than the standard equipment. I think that the reason why so many beekeepers do not attempt to control swarming is because they are overwhelmed by the complexity of all the different methods recommended by various books and instructors.

Chapter XVII

BEE BREEDING

Hereditary and Environmental Factors—The Object of Breeding —Secondary Objectives—Approaches to Bee Breeding—Selection of Breeding Stack—Queen Rearing, Miller Method—Cell Building—Mating Nuclei—Doalittle Method of Queen Rearing —Stanley System of Queen Rearing—Queen Introduction— —Queen Cages—Queen Cage Candy—Replacement of a Queen in a Strong Stock—Introduction ta a Nucleus—Queenless Stocks —Laying Workers.

THE development of bees, by breeding for increased productivity, is a matter of top priority for every beekeeper. Each and every beekeeper can and must do it to reach and maintain a level of economic production. It is not difficult; it does not require complicated equipment; it merely requires a simple understanding of the principles involved.

HEREDITARY AND ENVIRONMENTAL FACTORS (1)

Bees in the wild state vary enormously in their characteristics. This is Nature's way of ensuring the survival and spread of the species. By numerous crossings between strains, an abundance of hereditary factors is produced which provides for whatever eventualities may occur. Differences are to be seen in all the various characteristics of hees. They occur in the forms, size, shape and colour, and the functions, development and hehaviour, as well as in the ability to store honey. These differences always occur in hees which breed in the wild state, and they are hereditary. The indigenous bees in an area are not necessarily the ideal bees, hecause performance and productivity are not the main objects of Nature. In all races, the had strains, from the heekeeper's point of view, are more numerous than the good ones.

Environment has its effect on hehaviour and performance and on the selection of those strains which will survive and those which will die out. But, the differences in production in the same apiary during the same honeyflow, and other differences in form and function when environmental factors are equal, are due to hereditary characteristics.

The honeybee is no exception to the general laws of genetics formulated by Mendel.

Bees which are so ready to defend their hive that they are uncontrollable when kept in hives io the open, may be perfectly manageable when tbe hives are in a bee house. Here the environment of tbe cool and shade and tbe inability of the guard bees to get at the beekeeper to start stinging make the bees manageable. But it does not remove the bereditary factor of bad temper.

However, if the beekeeper steps in and removes the queens in tbe worse-tempered colonies and replaces them with queens raised from tbe best-tempered colonies, and if he continues to do this, the temper of bis bees will improve. Here the beekeeper by his breeding is introducing a factor into his apiaries wbich can be called environmental in that the strains in which the bereditary factor of bad-temper is most marked are eliminated and only tbe good-tempered colonies and their progeny are allowed to survive.

Similarly, if the queens of tbose colonies in an apiary whicb produce the poorest crops are removed and replaced by progeny from tbe queens baving good records of production, and this process is continued all tbe time, tbe average production per colony will be increased. Some of the progeny of queens and drones witb a good history of production will lack the hereditary factors of fecundity and industry, while otbers will have one or the otber, or both, in accordance with tbe general laws of beredity. The beekeeper then breeds only from those which have the desirable factors well developed, and eliminates tbe otbers.

THE OBJECT OF BREEDING (1)

The object of bee breeding is *a constant maximum honey yield with the minimum expenditure of time and money.* To attain this object, there are four vital characteristics which must be regarded as the *principal objectives* in bee breeding, oamely:

1. *Fecundity.* A queen must be able to produce the largest possible brood nest during the build-up period, before the honeyflow. The requirement in fecundity is at least eight or nine Dadant brood combs or ten or eleven Langstroth brood combs filled with brood.
2. *Industry.* The bees must bave an immense capacity for foraging. This is the most essential of all characteristics.
3. *Resistance to Disease.* This is a factor which must never be overlooked. Avoid breeding from strains which are susceptible to disease.

4. *Disinclination to Swarm.* Swarming causes a great deal of work and loss of time which would be otherwise spent by the beekeeper in managing more colonies. Swarming can ruin the chances of obtaining a honey crop. Strains prone to swarming are useless for modern beekeeping and swarming wastes the benefits of other good qualities.

SECONDARY OBJECTIVES (1)

Other characteristics, which all have a bearing on the constant maximum average honey yield, should be regarded as secondary objectives and are as follows:

1. *Long Life.* Queens and workers need to have the longest possible working life, particularly in the tropics with the long-drawn-out honeyflows and long periods of dearth.
2. *Good Flight Range.* This has an important bearing on the foraging ability of the bees. The greater the distance they can fly, the greater area of country they can cover in search of nectar sources.
3. *Keen Sense of Smell.* This also improves foraging ability and colony defence.
4. *Good Defensive Instinct.* Defence of the colony, particularly against wasps and ants, must be highly developed in bees in the tropics.
5. *Hardiness.* Whereas bees in temperate climates must be able to withstand cold and damp, in the tropics they must be able to withstand hot dry periods as well as excessively rainy damp periods.
6. *Good Conservation of Stores.* The bees must not be extravagant in the use of their stores during periods of dearth.
7. *Good Development in the Build-up Period.* The bees must build up without stimulative feeding and achieve full strength at the beginning of the honeyflow.
8. *Adequate Pollen Collection.* They must gather adequate pollen supplies for their needs, but not in excessive quantities.
9. *Readiness to Build Comb.* There must be a keenness to build comb, especially worker comb. Slow comb builders are given to swarming.
10. *Proper Arrangement of Stores.* Honey must be stored away from the brood nest until the end of the honeyflow period.

The following characteristics affecting bee management make the work of the beekeeper easier and have an economic value:

1. *Good Temper.* It must be possible to control the bees during management, but the achievement of good temper must not result in a loss of the instinct for defence.

2. *Calm Behoviour.* The bees and queen should remain fairly still on the comhs and not rush around when under manipulation.

3. *Disinclination to Use Propolis.* The gumming up of the movable parts of the hive with propolis considerahly increases the work of the heekeeper, hut it is difficult to eradicate.

4. *Freedom from Broce Comb.* Like propolis, hrace comb makes the manipulation of frame hives difficult.

5. *Disinclinotion to Drift.* This is particularly important where hives are kept close together.

6. *Cleonliness.* Bees that keep their hives clean are more resistant to diseases and pests.

7. *Good Coppings.* The making of good white cappings on the honeycomh is particularly important to the producers of honey in sections.

APPROACHES TO BEE BREEDING (1)

Inhreeding is hreeding from close relations having the desired characteristics in order to estahlish constancy in the passing on of the hereditary factors. Inhreeding is essential for progress hut it must he conducted on the hroadest possihle hasis to prevent over-hreeding, which can result in a loss of vitality. Inhreeding only hrings out those characteristics which are already present in the parent strain.

Cross-hreeding is an endeavour to unite the desirahle characteristics of one race with those of another race into one strain. From cross-breeding, completely new types of great practical value can he ohtained.

In the first stage, hreeding should be done from the hest of the indigenous strains. Every beekeeper can do this. While the ideal can only he ohtained by an exceptional stroke of luck, valuable types can be hred which come near it, within comparatively few generations and in a relatively short time.

When the desirable characteristics have been brought out in the local strains and no further progress can he made, it may be that certain essential factors such as fecundity or industry are deficient in the race. Then is the time to try cross-breeding, or the introduction of races which do possess the desired characteristics. This should he attempted only hy beekeepers experienced in hreeding. In my opinion, the failure of European races of *mellifero* introduced into tropical Africa and Asia has been due mainly to the inexperience of the beekeepers who bave attempted it. In addition, it may well he that *mellifero*, the hest strains of which have most of the desirable

characteristics well developed, lacks the factors of defensive instinct and hardiness to the extent required for tropical conditions.

SELECTION OF BREEDING STOCK

The beekeeper with a few hives will select the queen which has most of the desirable qualities for breeding. The accent in selection will be on productivity, but the other factors must not be neglected. The drones that will mate with the young virgins must also be given attention. That is more difficult as drones may come from other apiaries if these are fairly near. The only answer is to select another colony with the qualities desired and give the queen as much drone comb as you can find. You can obtain drone comb foundation and if, during the build-up period, you give a couple of frames containing this foundation to the chosen queen, you will flood the apiary with desirable drones and so greatly increase the chances of the virgins mating with drones of a good strain. The drone eggs must be laid at least twenty days before the eggs which will eventually become queens, in order that the drones will be mature in time to mate with the young queens.

The real value of the queen as a breeder can be assessed only by the performance of her progeny. Thus, when the apiary is fairly large, several queens will be selected as breeders and careful records kept of the performance of the progeny of each. Similarly, drones should be bred from several good stocks, and suppressed in all other colonies.

QUEEN REARING, MILLER METHOD

It is best if the queen selected for breeding is placed in an empty hive on a frame of brood. The bees off several other frames of young brood are shaken in to ensure that there will be a sufficient number of young bees to cover four frames. Two frames of food are given to this small colony. In this way the laying potential of the selected queen is conserved.

A frame is prepared having half a sheet of new unwired foundation securely fixed to the top bar. This frame is put beside the frame of brood in the middle of the hive of the selected queen. If there is no honeyflow, the small colony should be fed. In seven days' time the foundation will be drawn and will be full of eggs and perhaps some larvae. Probably the bees will have started to build drone comb below the worker comb. Cut off the drone comb and any comb that has no eggs in it so that all along the bottom of the comb there are cells containing worker eggs. The comb is now ready to be put in the cell-

building colony. This method is excellent when only a few queens are required.

CELL BUILDING

The cell-building colony is made by removing the queen seven days beforehand. After seven days, examine the combs carefully and destroy all queen cells. This colony may be the one from which the breeder queen was removed. It will now have no means of raising a queen of its own.

Put in the prepared frame containing the eggs and young larvae of the breeder queen. The powerful queenless colony will build fine queen cells round the edges along the bottom of the comb, and probably some on the face of the comb also. Ten days later, the queen cells will be ripe and they should be cut out and given to the mating nuclei.

If it is not desired to raise further queens from that breeder, she may be reunited with her small colony to her original stock. Alternatively, if the queen is wanted for further breeding, she should be kept in the small colony to conserve her egg-laying powers, and the queenless stock given one of the ripe queen cells.

Another method of preparing a cell-building colony is to remove the queen and all eggs and young brood. A nucleus can be made with the queen and two or three combs of unsealed brood and set beside the parent colony, if it is to be reunited later. The remaining frames of unsealed brood, without bees, can be given to any other colony. About twelve hours later the colony will be in a mood to build queen cells and the prepared frame with its eggs and young larvae is inserted.

MATING NUCLEI

Twenty-four hours before they are required for receiving queen cells, the mating nuclei are prepared. The most convenient type of mating nucleus is a standard brood box which is divided into three by partitions. Each compartment must be completely screened off from the next and must have its own entrance hole. The entrance holes should be located one in each side of the hive. They can consist of half-inch holes drilled through the side runners and back of a standard floor, the entrance-closing block being left shut. Each compartment has its own inner cover and a telescopic roof is put over the top.

Thus using standard equipment, the nuclei can be united by removing the two partitions at the end of the queen-breeding season and the hive used for honey production.

The mating nuclei are stocked with two frames of brood and one of food and a couple of extra frames of bees shaken in. If the entrance is partially blocked with a little grass, the bees are less likely to drift back to their original stock. Twenty-four hours later they will be ready to receive a ripe queen cell each. The cells should be cut out of the comb very carefully. Without shaking, chilling or overheating in the sun, they are transferred to the nuclei. The cell is put in the nucleus between two of the combs where the bees are clustering. A depression is made in the surface of the comb with the thumb and the cell inserted the correct way up.

After mating, the queen is allowed to lay for a few days in the nucleus before being taken out and introduced elsewhere. This enables the beekeeper to see if she is properly mated and also it keeps up the strength of the nucleus. Four hours after the queen has been removed for introduction elsewhere, another cell can be given. If more than four hours have elapsed before the new queen cell can be given, it is necessary to put the cell in a queen cell protector. Alternatively, wait seven days, then cut out the emergency queen cells before putting in a ripe queen cell from the cell-building colony.

THE DOOLITTLE METHOD OF QUEEN REARING (2)

If a large number of queens is to be raised, the beekeeper makes the wax queen cups himself, sticking them on to cross-pieces which fit into adapted brood frames. Larvae, about twelve hours old, are taken out of the cells of an ordinary brood comb from the breeder queen's nucleus, and put into the wax cups. Two frames containing 90 to 120 transferred larvae can be given to the cell-building colony.

The frames are prepared by nailing pieces of wood to the inside of the end bars of a brood frame so as to leave three or four slots two inches apart to take the ends of the cell bars. The cell bars can be made from spare bottom bars cut so that they just fit between the end bars.

To make the queen cups, a piece of round wood about 3 in. long and $\frac{3}{8}$ in. diameter is used. From a point $\frac{1}{2}$ in. from one end the rod is tapered down to $\frac{5}{16}$ in. diameter at the end. The tip is then rounded.

Some clean light wax is melted and the vessel containing the wax is stood in a larger vessel of hot water to hold the wax at a little above melting-point. The rod is dipped in cold water, shaken to remove excess water, and then dipped into the wax to a depth of about $\frac{3}{8}$ in., removed quickly and held in the air until the wax solidifies. It is quickly dipped in and out of the wax again, less deeply than the

first time, and allowed to set. This is done four or five times and then the cup is held carefully between the fingers and pulled off while twisting the rod. The rod is again dipped in water, the excess shaken off and another cup made in the same way. The cups are stuck with melted wax on to the bars about $\frac{3}{4}$ in. apart.

A transferring tool is made of a piece of stiff wire about 14 gauge by heating the end red hot and beating it flat with a hammer and then turning the last $\frac{1}{16}$ in. at the end over almost at right angles, to make a minute spoon for lifting out the larvae. The wire should be bent a little about $\frac{1}{2}$ in. from the end so that the fingers do not obscure the view into the cell.

When using the grafting method it is usual to put a frame of drawn comb into the nucleus containing the breeder queen. About four days later there should be plenty of larvae twelve hours old or less. These are carefully lifted out of the cells with as much royal jelly as possible and put into the queen cups. This should be done as quickly as possible so that the frame of grafted larvae can be given to the cell-building colony with the minimum of delay. Some queen breeders put a little royal jelly diluted with water into the queen cups before transferring the larvae. It is most important that the larvae are not exposed to unnatural conditions and are not allowed to become short of royal jelly before being accepted by the cell-building colony.

THE STANLEY SYSTEM OF QUEEN REARING (3)

Although the Doolittle method is used by most commercial queen breeders, it has disadvantages. The transfer of the minute larvae from the worker cells to the artificially made queen cups is a very delicate operation and calls for considerable skill if the young larvae are not to be damaged. It is difficult to transfer enough royal jelly; some is always left behind in the worker cells, so the breeder resorts to the rather dubious expedient of priming the queen cup with royal jelly taken from mature queen cells and diluted with water. Also this work must be carried out in a warm moist atmosphere to prevent chilling or drying out of the larvae. The larvae are separated from the care of the bees for rather a long time while all the queen cups in a bar or frame are being stocked. As queen rearing has to be carried out to a rigid programme, it is often necessary to open up cell-building colonies and mating nuclei when the weather is bad.

When only a few queens are required, the Miller method is probably the best. But for the production of large numbers of queens under the most natural conditions possible, the Stanley system is recommended.

Some special but inexpensive equipment is needed for this method. The Stanley queen cell consists of a brass tube, sharpened at one end to provide a cutting edge. On the other end is fitted a perspex tip. Through the tube fits a plug having an enlarged cork-shaped top.

A perspex swarm box cover is used over the cell-building colony. This consists of a sheet of perspex, usually divided into three or more removable panels, each containing a series of holes to take the Stanley queen cells. When not in use, the holes are closed by flexible plugs. Holes are also provided for feeding the colony.

For carrying the ripe queen cells from the cell-building colony to the mating nuclei a perspex warm box is used. This has double walls and a series of holes in the top to take the queen cells.

The mating nuclei have special covers of perspex with two holes, one for feeding and the other to take the queen cell in such a position that it comes between the frames.

The cell-building colony is prepared in a swarm box, a hive ventilated at the bottom. Two frames of honey and pollen, one of drawn comb and two others of foundation, are put in the swarm box. The hive from which the bees are to be drawn is fed with sugar syrup for two days beforehand. To stock the swarm box, the queen and the frame she is on are placed in a separate hive out of the way. The bees off at least five frames from the centre of the brood nest are shaken into the swarm box. A special funnel can be used for this. More bees are added if necessary; the more bees there are the more cells they can look after. When the swarm box has been stocked with bees the cover is replaced and care is taken to see that all openings are closed. The box is placed in a dark corner of a room or bee house, and the bees are fed with sugar syrup. About twelve hours later the bees will be ready to accept queen cells.

To prepare the queen cells, select from the breeder queen's nucleus a comb which has been used for breeding several times and which contains larvae about twenty-four hours old. Brush off all the bees and wrap the comb in a cloth while taking it and the swarm box into a warm room. Select a suitable area of larvae on one side of the comb and scrape the other side of the comb down to the mid-rib with a sharp knife. Remove the plugs from the Stanley queen cells, and with your back to the light, press the sharpened end of the tube over the selected cell, at the same time pressing the ball of the finger of the other hand against the mid-rib at the back of the comb. Press the tube in with a screwing motion until it is felt against the finger at the back of the comb. The cell is now cut out of the comb and lies in the tube. Push in the plug which forces the cell right through the

tube to the perspex tip, exposing half the cell wall. Cut this off flush with the perspex tip with a sharp knife. Open the walls of the wax cell out against the perspex tip with the blunt point of a pencil. Open one of the holes in the perspex cover of the swarm box and put in the Stanley queen cell containing the larvae. Up to twenty-five cells can be started in the swarm box at one time. The whole process of preparing each cell takes about five seconds. Put the swarm box back in a dark corner and leave it there for twenty-four hours, feeding the bees meantime. After that the bees can be allowed to fly.

At any time it is possible to see at a glance how the cells are progressing, either by looking through the perspex cover or lifting out the cells one at a time. Any that have not been accepted can be regrafted.

When the cells are mature they are taken out of the cell-building colony and put into the swarm box and then distributed to the mating nuclei which have been prepared beforehand. If the queen cells were left to mature in the swarm box, the same bees should not be given another set of cells to build because they will be past the best stage for producing royal jelly. They can be left with a ripe queen cell.

The advantages of this system are that once the swarm box has been stocked it is not necessary to open up the colony. All the work is done through holes in the perspex covers. The method of grafting ensures that the larvae suffer the least disturbance, and the time they are unattended by bees is very short.

QUEEN INTRODUCTION

The recent discovery of queen substance and the appreciation of its significance by Butler (4) has led to a simplification of the technique of queen introduction (5).

Queens are introduced to replace old and failing queens and otherwise unsatisfactory queens. No queen should be kept for more than two years in a honey-producing colony. Some beekeepers requeen every year and this may be necessary if the breeding seasons are long and heavy. In these cases the old laying queen has to be removed and replaced by a young queen.

When making increase, the nucleus or stock develops most quickly if given a young laying queen. If a strong colony becomes hopelessly queenless, a special technique is required to requeen it. A weak colony in that condition is not worth bothering about.

QUEEN CAGES

Before going further, the cages which are used for carrying and introducing queens must he described.

The *simple introducing coge* consists of a piece of large-mesb wire gauze rolled into a cylinder or folded to give an ohlong sbape 3½ in. (90 mm.) long by ¾ in. (20 mm.) wide by ½ in. (13 mm.) bigh. The apertures in the wire gauze must be as large as possihle without allowing the bees to pass through, ⅛ in. (3·2 mm.) square and not under any circumstances less tban $\frac{1}{10}$ in. (2·5 mm.) square (6). One end of the wire is plugged with a piece of wood. This may have a hole drilled through it ⅜ in. (10 mm.) diameter fitted witb a cork. The other end may be blocked with a similar piece of wood or covered witb a single thickness of a piece of newspaper, according to its usc.

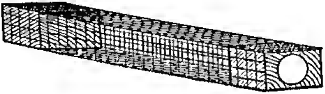


FIG. 29

SIMPLE INTROOUCINO CAGE

The reason wby the size of the holes in the wire gauze is so important is that tbe bees must be ahle to lick the queen and obtain queen substance as well as feed her. From heing fed hy the hees the queen ohtains the same scent as the colony. The colony is ahle to get queen suhstance and is thus inhihited from huilding queen cells, and is prepared to accept the queen when she emerges from the cage.

The *postal cage*, used for sending a queen a long distance accompanied hy ahout twelve worker bees and candy for food, is made out of a hlock of wood ahout 4¼ in. (108 mm.) long, 1½ in. (38 mm.) wide hy 1 in. (25 mm.) thick. It has three adjoining holes 1⅛ in. (29 mm.) diameter hored partly through the wood. Two of the holes provide accommodation for the queen and hees and the third, at one end, contains the candy. A ⅜ in. (10 mm.) hole is drilled in hoth ends. The end that is to contain the candy is dipped in melted beeswax to coat the hole to prevent the wood from ahsorhing moisture from the candy. The hole containing the candy is covered with a wax card, hoth on top over the 1⅛ in. hole and at the end over the ⅜ in. hole. All over the top is tacked wire gauze. After the queen and

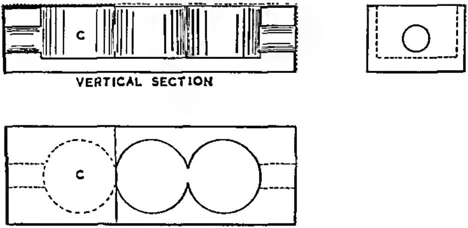


Fig. 30
POSTAL QUEEN CAGE
C, Candy chamber.

the attendant bees have been put in through the bole in the other end, that too is covered with a piece of wire gauze. Before introduction to a colony, the queen by herself is transferred to a simple introducing cage.

QUEEN CAGE CANDY

Candy for putting in queen cages is made of a mixture of one pound of honey to four pounds of icing sugar. The honey is heated gently to about 150° F. (65° C.). The icing sugar is then added while stirring. When as much icing sugar has been added as can be stirred in, the candy is removed from the container and placed on a board covered with icing sugar. Knead the mixture, adding more icing sugar until the mass has the consistency of putty. If the candy is too runny, add more icing sugar. Store the candy in a closed tin until needed. Do not use granulated sugar for making candy.

REPLACEMENT OF A QUEEN IN A STRONG STOCK

Probably the most common type of introduction the beekeeper has to perform is to replace a queen who is past her best with a new young laying queen, or to replace an unsatisfactory queen with a young laying queen of a better strain.

First of all the old or unsatisfactory queen must be found and removed from the colony. Then the new young laying queen is put between a pair of frames in a simple introducing cage, one end of

which is covered only by a single thickness of newspaper. The other end is corked. During the time the bees take to eat through the newspaper to release the queen, the colony is able to recover from the disturbance caused by the beekeeper. The queen, being on her own in the cage, solicits food from the bees through the wide-mesh wire gauze, and they in turn are able to obtain queen substance. Thus, when the queen comes out of the cage she is acceptable to the colony. The percentage of successful introductions using this method is very high indeed, 90 per cent or more.

If the queen to be introduced is particularly valuable or is of a different subspecies, it is recommended that she be introduced in the simple introducing cage in the same way to a nucleus, the bees of which are all young.

INTRODUCTION TO A NUCLEUS

The nucleus is made up of two brood combs of emerging brood which have first been lightly shaken to remove the older bees. The young bees cling more tightly to the comb. Two combs of food are also put in, having been lightly shaken first. The strength of the nucleus is made up by shaking in more bees from brood combs which were first lightly shaken. There must be sufficient young bees to cover the brood. Between four and six hours after making up the nucleus, introduce the queen in the simple cage with the single thickness of newspaper over the end. Let the new queen settle down to laying in the nucleus for a few days and then remove the old queen from the main colony and place the nucleus complete with the new queen in the centre of tbe brood nest. Sprinkle a little sugar syrup on tbe bees of both tbe colony and the nucleus to stop any fighting.

QUEENLESS STOCKS

We must now consider what to do in the case of a colony which has no young brood and wbose queen cannot be found. Tbere may be a virgin in the hive and sbe will kill any laying queen whicb you give to the colony. In a case of douht, insert a frame of eggs and young larvae and make sure that the bees bave plenty of food. At the next visit there will be either eggs and young brood if there has been a virgin, or else the hees will have demonstrated their queenlessness by building emergency cells on the comh you gave them. Either let them raise a queen from one of the cells or else give them a laying queen in a simple introducing cage, having first destroyed the queen cells.

LAYING WORKERS

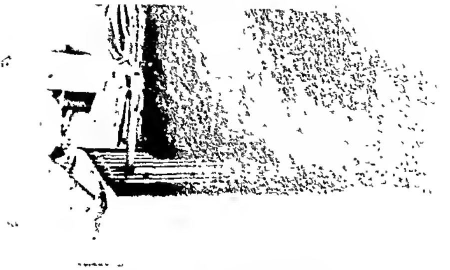
If a stock becomes hopelessly queeoless for some reason and is unable to raise a new queen through lack of eggs or young brood, some of the workers will start egg laying. These eggs will be found scattered about in worker cells, sometimes many eggs in one cell, and being usually male, they produce stunted drones. The sealed brood has the typical drone cell cappiog.

If the colony is a small ooe, and very often it is when it gets into this state, it is not worth bothering about. Take the hive some distance away from its stand and quickly shake off all the bees from the frames and out of the box. Then remove the brood box and give the frames to another colony to clear up.

Should laying workers be detected in a strong colony at an early stage, then it is worth requeening it. A colony in such a condition will kill a laying queen if introduced straight away. First a virgin is given in a simple cage, plugged up at both ends, and the cage is left in the hive for three days. Then the cage with the virgin is removed and a young laying queen given in a simple cage with a single thickness of newspaper over one end. Alternatively, the virgin can be released and allowed to mate and lay in the colony.

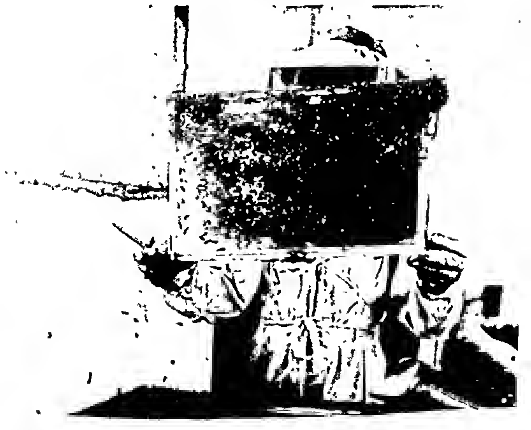
REFERENCES

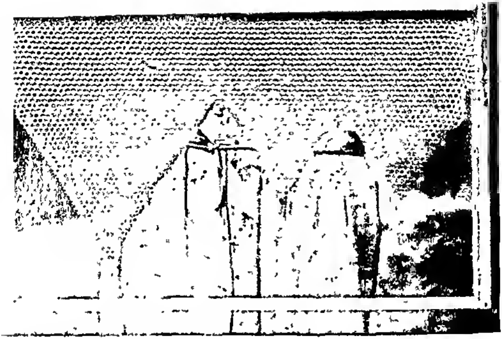
1. ADAM, BROTHER (1954). 'Bee Breeding.' *Bee World* 35: 4–13, 21–9, 44–9.
2. LAIDLAW, H. H. AND ECKERT, J. E. (1950). *Queen Rearing* (Hamilton, Ill.: Dadant).
3. STANLEY, P. W. *The Stanley System of Queen Rearing* (Hambrook Grange, Chichester).
4. BUTLER, C. G. (1954). 'The importance of "queen substance" in the life of a honeybee colony.' *Bee World* 35(9): 169–76.
5. BUTLER, C. G. AND SIMPSON, J. (1956). 'The introduction of virgin and mated queens directly and in a simple cage.' *Bee World* 37(6): 105–14.
6. FREE, J. B. AND BUTLER, C. G. (1958). 'The size of apertures through which worker honeybees will feed one another.' *Bee World* 39(2): 40–2.



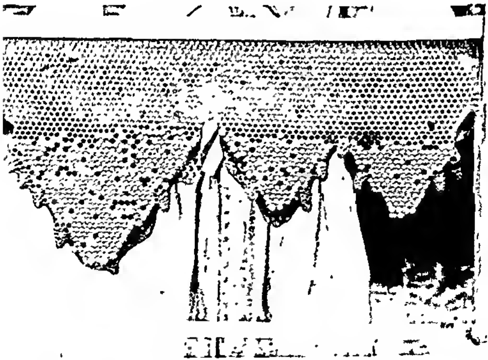
52. Lifting a brood comb out of the hive

53. Inspecting the reverse side of a brood comb

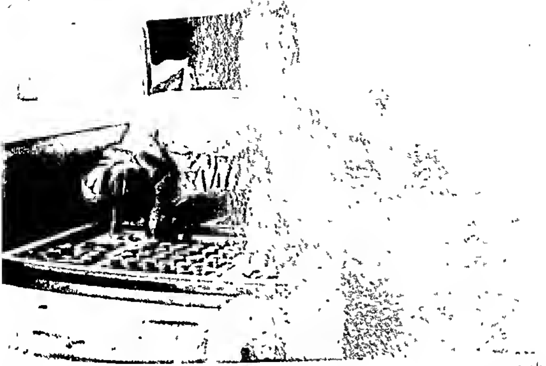




54. Queen rearing, Miller method. Comb containing eggs and young larvae of the breeder queen trimmed ready for putting into the cell-building colony

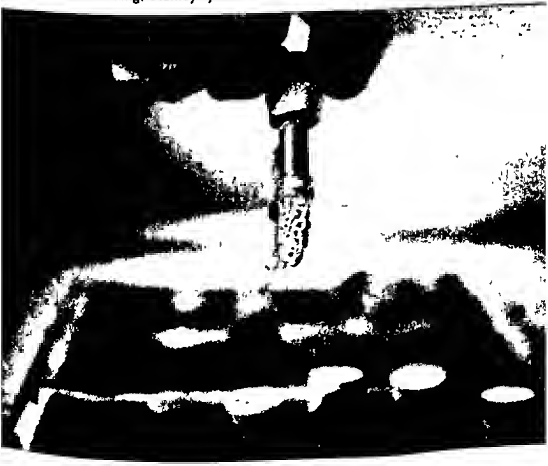


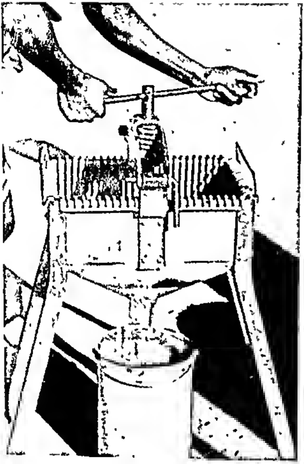
55. Queen rearing, Miller method. The same comb seven days later with sealed queen cells along the edges of the comb



56. Queen rearing, Stanley system. The man on the [illegible] comb for larvae of an age suitable for grafting. The man on the [illegible] prepared queen cell into the swarm box cover

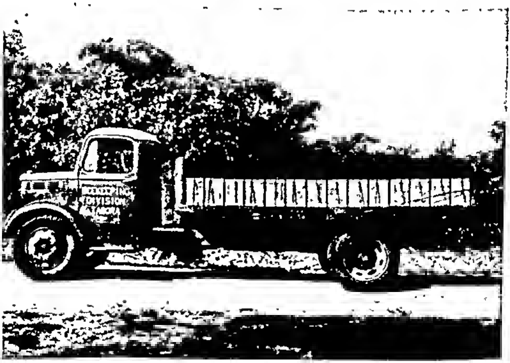
57. Queen rearing, Stanley system. A sealed queen cell seven days after grafting





58. Pressing honey from crude combs

59. Honey loaded for transport from a beekeeper's camp to a central packing station



Chapter XVIII

SEASONAL MANAGEMENT

Period of Dearth—Build-up Period—Honeyflow Period—Harvest Period—Summary of Seasonal Management.

It is impossible to set down a month-by-month programme of management for beekeepers in the tropics because every district has its own peculiarities of climate and vegetation. Instead of working on a system of winter, spring, summer and autumn management as in temperate climates, we have to divide the year up into periods of dearth, build-up, honeyflow and harvest. In those parts of the tropics which are near the equator this cycle may occur twice in a year. Set out in this chapter is the management appropriate to each period in the seasonal cycle in tropical areas and which is also applicable in the similar seasons in temperate climates.

PERIOD OF DEARTH

Corresponding to autumn and winter in temperate climates, this is the time when there is no nectar and no pollen available to the bees. Egg laying decreases, and may cease altogether if the period of dearth is prolonged. The dearth may be due to a prolonged dry season, or to very heavy rains in monsoon areas, or to a combination of drought followed by monsoon rains.

In the dryer areas, the main problem the bees have to contend with is keeping the hive cool. This is when they benefit very much from shade. Also water is essential for the bees to use in the hive to keep it cool. The beekeeper must ensure that there is some source of water available to the bees near the apiary.

In places where there is very heavy rain at this period, the hives should be sheltered to keep them dry. A damp hive seems to sap the strength of a colony, fungus growth appears and the wax moths and other pests are able to get a foothold.

At this season, whether it be wet or dry or both, attention must be paid to the defence of the hive against ants. If wasps or hornets are a danger, the hive entrance must be reduced to a size the bees can

About eight weeks before the honeyflow is expected, the brood nest expansion should be started. In the case of hives with large brood boxes, Modified Dadant, a frame of empty comb is put between the brood nest and the comb containing pollen and honey. With the smaller Langstroth hives, a second brood box is given, or, if the colony had two boxes during the period of dearth, the position of the boxes is reversed. If no nectar is coming in and there are less than two full frames of food, start feeding. Each week, put another empty frame between the brood nest and the store comb. Some beekeepers do this alternately on one side of the brood nest and then on the other side the next time. Others find it more convenient to always do it on one side.

When there are only two more frames in the brood nest remaining to be filled, give a super. If you have only foundation, put the super on top of the brood box and put the excluder in under the super only after the bees have started drawing the foundation and storing in it. Make sure that the queen has not gone up into the super. If she has, find her and put her in the brood box.

Towards the end of the build-up period and about the beginning of the honeyflow, swarming preparations may be started. By keeping ahead of the bees in their requirements for comb space, much swarming trouble will be avoided. Be ready to take control measures at this time, and if you can carry out regular inspections for swarm control, this is the time to start.

HONEYFLOW PERIOD

One of the most important aims in bee management is to get the colonies built up to strength ready for the honeyflow. You do not want your bees to be using the honeyflow for building up, and that is what will happen if you let your bees run short of stores at any time during the build-up period. By the time the honeyflow starts and nectar is being brought in in greater quantities than the bees need for their own daily requirements, all hives should have at least one super on.

As the honeyflow starts, if the bees have two boxes for the brood nest, put the queen down into the lower box and put the queen excluder between the two boxes. As the brood emerges in the upper box, honey will be stored there and in due course it will be used by the bees during the next period of dearth and build-up period.

Give extra supers before the bees start to show their need for them. If you allow the bees to fill one super right up before giving them another, you will probably have lost a third of your crop, and

defeod. As this makes tbe task of keeping the hive cool more difficult, sbade from tbe sun sbould be provided.

At this time of the year check over spare hives and equipmeot and get hives aod frames assembled ready for the next season. Treat the hives witb preservatives or paint them now so that they will not be wet and smelly wheo you have to use them for tbe bees.

Also, this is a good time to read up bee books and to plan operatioos for tbe coming active seasons.

BUILD-UP PERIOD

Witb the first flowering of the trees or herbs, tbe bees will start to bring in nectar and polleo. There will not be mucb at first, but enough to start tbe queen laying. The temperature of the brood nest now bas to be maintained and the bees start coosuming more hooey. This consumptioo of stores is reflected in the daily hive weights whicb sbow a small drop each day when brood rearing commenees. Soon, however, as more nectar becomes available, tbe weigbt will become coostant. This is the time wben stores plus daily intake are beiog turned into brood and hees.

There must be sufficient stores io the hive to permit this conversion into bees to continue on ao ever-increasing scale until the honeyflow starts. How many pounds of honey tbe bees should have io store for this build-up period depeods on the time that elapses hetween the first floweriog aod the first boneyflow. Never, at any time, should there be less than fifteen pouods of booey in a hive; this is at least two M.D. brood frames full. If the bees look as though they are going to ruo short, feed, and feed fast. Stores of food in tbe brood box become bees to collect the crop; the more stores, the more bees, witbin the limits of the queen's fecundity, aod the more bees there are to collect tbe crop, tbe bigger the harvest. Never grudge your bees a brood box full of honey when you collect the crop.

Early in this build-up period do a careful inspection of the brood box. Take out any faulty combs, if empty. If they have honey in them, put them next the wall of the hive. If there is brood in them, put tbem on the outside of the brood nest.

Wben doing this detailed iospection, examioe the brood carefully. Note whether it is in a compact block on the combs; that will indicate a good queen. See whetber it is healthy in appearance and smell. Any large hive beetles you fiod, pick out and destroy. See tbat tbere are no hiding-places for small hive beetles and wax moth *larvae* which the bees cannot reach. Should any stocks be found to be queeoless at this early stage, unite them to medium-sized colooies.

About eight weeks before the honeyflow is expected, the brood nest expansion should be started. In the case of hives with large brood boxes, Modified Dadant, a frame of empty comb is put between the brood nest and the comb containing pollen and honey. With the smaller Langstroth hives, a second brood box is given, or, if the colony had two boxes during the period of dearth, the position of the boxes is reversed. If no nectar is coming in and there are less than two full frames of food, start feeding. Each week, put another empty frame between the brood nest and the store comb. Some beekeepers do this alternately on one side of the brood nest and then on the other side the next time. Others find it more convenient to always do it on one side.

When there are only two more frames in the brood nest remaining to be filled, give a super. If you have only foundation, put the super on top of the brood box and put the excluder in under the super only after the bees have started drawing the foundation and storing in it. Make sure that the queen has not gone up into the super. If she has, find her and put her in the brood box.

Towards the end of the build-up period and about the beginning of the honeyflow, swarming preparations may be started. By keeping ahead of the bees in their requirements for comb space, much swarming trouble will be avoided. Be ready to take control measures at this time, and if you can carry out regular inspections for swarm control, this is the time to start.

HONEYFLOW PERIOD

One of the most important aims in bee management is to get the colonies built up to strength ready for the honeyflow. You do not want your bees to be using the honeyflow for building up, and that is what will happen if you let your bees run short of stores at any time during the build-up period. By the time the honeyflow starts and nectar is being brought in in greater quantities than the bees need for their own daily requirements, all hives should have at least one super on.

As the honeyflow starts, if the bees have two boxes for the brood nest, put the queen down into the lower box and put the queen excluder between the two boxes. As the brood emerges in the upper box, honey will be stored there and in due course it will be used by the bees during the next period of dearth and build-up period.

Give extra supers before the bees start to show their need for them. If you allow the bees to fill one super right up before giving them another, you will probably have lost a third of your crop, and

you migbt have caused the bees to start swarming preparations stimulated by congestion. Give ynur next super as soon as you see tbat tbe bees are working in three-quarters of tbe combs in tbe top super. Never let them get into a state wben they have less tban two more combs to work on. Always put a fresh super on top of the last one. Once tbe bees are wnrking in a super through a queen excluder, it is quite safe to give either drawn combs or foundation in the additional super because by then they are quite used to passing through the excluder.

The end of tbe build-up period and the beginning of the boneyflow is the time to start queen rearing. This can be continued throughout the boneyflow.

Should you want to make increase hy dividing strong stocks into nuclei do it as near the beginning of the honeyflow as possible, and as soon as you have ripe queen cells or laying queens to give to tbe nuclei.

Towards the end of the honeyflow you can make your increase by taking one or two frames of brood and bees from each of several strong stocks and putting them together in order to make new stocks having six or eight combs each of bees and brood. Give them a young laying queen.

HARVEST PERIOD

From the point of view of the crop, the honeyflow ends when tbe bees stop storing in tbe supers. Leave tbe supers on for another ten days, so that tbe boney will be properly ripened hefore removal. If you are going to move the bees as soon as tbe flow ends, get the supers off as soon as they are sealed and put tbe empty supers on before the move. Not only does this provide additional clustering space for the bees during the move, it also enables the bees to begin storing the new crop as soon as released. There is always a danger of tbe bees starting robbing when the honeyflow ends, so be careful to keep the supers covered when removed from the hives.

At the next visit after tbe supers have been removed check up on tbe condition of stores in the brood box. Make sure tbat the bees have enougb stores to last tbem until the next honeyflow. Feeding at this time of tbe year is a tricky business. You may find that, instead of storing the food, the bees start breeding heavily and use up all you bave given them. Unless you are certain what time is the best for feeding the bees, give them combs of sealed honey in the brood box where it is required. If you have no spare brood combs full of boney, then select one strong stock and put a brood box over a queen excluder and feed as fast as you can so tbat they fill up all

the brood combs. Then distribute the filled combs to those hives which are short of stores.

When checking up on the stores position, also check the queens and requeen as necessary.

As soon as possible after you have removed the honey, start extracting it. Once you have removed the supers from the care of the bees, the combs are open to the attacks of small hive beetles, ants and wax moths. It is easiest to extract as soon as the supers are taken off the hives, but if it cannot be done immediately, store the supers away from ants and extract within two days.

SUMMARY OF SEASONAL MANAGEMENT

Period of Dearth

Shade and shelter hives from sun, rain and wind.
Ensure that water supplies are available nearby.
Check defences against ants and wasps.
Prepare equipment for the next season.
Read and plan next season's work.

Build-up Period

Check brood nest.
Ensure that the bees have ample stores.
Feed if necessary.
Remove faulty combs.
Unite queenless stocks.
Give room for brood-nest expansion.
Give super before hive becomes overcrowded.
Start swarm control inspections.
Start queen rearing.

Honeyflow Period

Give extra supers in advance of requirements.
Continue queen rearing.
Make increase if required.

Harvest Period

Remove supers.
Extract and pack honey and prepare beeswax.
Check stores in brood box.
Requeen as required.

As the beekeeper gains experience, he should strive to reduce interference with colonies to the minimum required for good management.

IV

THE CROP

Chapter XIX

HONEY AND BEESWAX

The Nature of Honey—Colour of Honey—Flavour—Water Content—Granulation—The Origin of Beeswax—Colour of Beeswax—Chemical and Physical Properties of Beeswax—Ghedda Wax—Trigona Wax—Paraffin Wax.

THE NATURE OF HONEY

Honey is the sugary product of the honeybee. The bees collect nectar, a sugary fluid containing 20 to 40 per cent sucrose and most of the rest water. This nectar is secreted by the flowers of trees, shrubs and herbs. Other sugary fluids are obtained from extra-floral nectaries and from the secretions of aphids, but these are usually of inferior quality and are termed honeydew.

The nectar is drawn up by the tongue of the bee into its crop or honey stomach. On returning to the hive, the nectar is regurgitated and eventually placed in the cells of the comb to ripen. This ripening takes place by the action of an enzyme, invertase, and by the evaporation of water by the fanning of the bees in the hive. Invertase is present in nectar in the flower and more is added by the bees. It reduces the sucrose to dextrose and levulose.

Honey is variable in the proportions of its constituents. This variation is due to differences in the nectar produced by different species of plant and to variations in the nature of the soils on which the plants grow. Honey, when fully ripened, consists of the following substances, approximately in the percentages indicated (1):

	Per cent
Levulose (Fructose)	41·0
Dextrose (Glucose)	35·0
Sucrose	1·9
Dextrins	1·5
Minerals	0·2
Undetermined	3·4
Water	17·0

THE COLOUR OF HONEY

The colour of honey is dependent on the species of plant from which the nectar was gathered. Variations in soils also have an effect on colour. There is usually a correlation between colour and flavour, the darker or more reddish honeys being of a stronger or more pronounced flavour than the lighter-coloured honeys which have a more delicate flavour. An exception to this is the honey from sisal. Sisal honey is very pale in colour but although somewhat insipid in flavour it is most unpleasant.

Heat has an effect on the colour of honey. Heating, particularly prolonged heating, causes a darkening of the colour. High temperatures oxidize some of the sugars, forming caramel, which is brown and gives the honey a burnt flavour.

The colour of honey is usually measured by means of an apparatus containing a wedge of amber glass. The thin end is colourless and the thick end is dark amber. Most of the major honey-producing countries grade honey in relation to the measurements given by this apparatus, the Pfund colour grader, but owing to the cost of the equipment, more simple devices are often used, consisting of coloured glasses which, when used with sample bottles of a specified size, give the limits of the colour grades. The United States official standards divide the colours of honey into the following grades (2):

Millimetre Reading on Pfund Grader	*Colour Grade*
0– 8	Water White
8– 17	Extra White
17– 34	White
34– 50	Extra Light Amber
50– 85	Light Amber
85–114	Amber
114–140	Dark

Other countries use similar standards. In Tanganyika it has been found that for practical purposes only four grades are needed:

0– 34	White
34– 50	Extra Light Amber
50– 85	Light Amber
85–140	Dark

Due to the connection which often exists between colour and flavour, and because the lighter-coloured honey has a more pleasing appearance in the eyes of many customers, the dealers place

considerable importance on the colnur grade of honey. Normally, Extra Light Amber and White grades fetch the highest prices on the world market, and Light Amher is a little lower. Honey darker than Light Amber is priced rather lower and is often regarded as fit only for manufacturing purposes.

FLAVOUR

The materials in honey which give it its flavour and aroma are extremely volatile. Therefore honey must be bandled very carefully if its fine flavour and aroma are not to be lost and the honey reduced to a characterless sweet syrup. Most people find that honey tastes best in tbe comb, and this is undouhtedly so, for no matter how carefully the honey is separated from the wax of the comb, it is unavoidahly exposed to the air and some of the volatile materials are lost. Wben the honey is beated this loss is more severe and if heating is carried out witbout a full appreciation of what is happening to the honey, the honey may he ruined.

Clearly, in order to preserve tbe flavour and aroma of honey, it should be exposed to the air as little as possible, and not heated more than is absolutely necessary, and then in covered vessels, but if it can be avoided, honey is best if it is not heated at all.

WATER CONTENT

The water content of honey, usually measured by its specific gravity, is of great importance to its keeping qualities. If the water content is ahove a certain level there is a danger of the honey fermenting, partieularly when it granulates. The fermentation is caused by yeasts which are usually present in honey and become active when the water content is high enough.

Honey, when fully ripened hy tbe bees, is safe from fermentation as the water content is reduced to 17·4 per cent or less, giving a specific gravity of 1·4212 gms./cc. at 20° C. or more. Honey with the water content reduced to this level does not ferment even when granulated. Thus the first step to ensure that honey will keep without spoiling is to leave it on the hive until fully ripened by the bees. When all the honey in the comhs is scaled over it is normally fully ripened, but care should be exercised in damp weather as the honey may have reabsorbed some water. Honey that is removed from the hive when nectar is being collected from the flowers will contain a proportion of unripe honey, and will thus have a high water content.

Being bygroscopic, honey absorbs moisture from the atmosphere.

Thus honey must be packed in airtight containers as sooo as possible after it has heen removed from the care of the hees.

The water conteot of honey is usually measured by means of a hydrometer, usually with a thermometer incorporated in it. Such hydrometers for use with honey have a scale reading from 1·34 to 1·44 gms./cc. specific gravity and the enclosed thermometer reading from 10° C. to 50° C. As the minimum specific gravity at which hooey is safe from fermentation is 1·4212 gms./cc. at 20° C. (68° F.), these points are usually in a distioctive colour. As the temperature of the honey at the time of measuremeot may he ahove or below 20° C. a table is referred to showiog the specific gravities at other temperatures, as follows:

Minimum Specific Gravity Readings at Different Temperatures

Temperature °C.	°F.	*Minimum Specific Gravity* *gms./cc.*
5	41	1·430
10	50	1·427
15	59	1·424
20	68	1·421
25	77	1·418
30	86	1·415
35	95	1·412
40	104	1·409
45	113	1·406
50	122	1·403

There are also available very handy refractometers which can be used for measuring the refractive index of honey. This too gives an indication of the water content. A water content of 17·4 per ceot gives a refractive index of 1·493 at 20° C. A correctioo of minus 0 00023 is applied to the refractive index for each 1° C. iocrease in temperature. A higher water content gives a lower refractive index reading.

Another measure sometimes used is the weight of one gallon of honey. One Imperial gallon of honey with a water content of 17·4 per cent weighs 14 pounds 3¼ ounces and a U.S. gallon weighs 11 pounds 13 ounces. If there is more than 17·4 per ceot of water in the honey, the weight will he less.

GRANULATION

If the dextrose in hooey crystallizes, the honey is said to be granulated. Most kinds of honey granulate naturally if the temperature is

below 75° F. (24° C.). Some granulate very rapidly, forming fine crystals throughout the whole of the honey. Others granulate slowly, forming large crystals.

As the dextrose crystallizes it leaves the remaining solution, mainly levulose in water, with a higher proportion of water. Thus the danger of fermentation is increased. But if the water content of the honey when liquid was 17·4 per cent or less, the honey will not ferment, even when granulated.

Normally the dextrose crystals remain in suspension in the levulose solution, giving the honey a smooth even appearance. But in some honeys, especially if the water content is too high, the dextrose crystals settle to the bottom half of the honey leaving a thin levulose solution above.

Some people prefer their honey in the granulated form, others, particularly if they use it for cooking, prefer it in the liquid form. The rate of granulation is dependent on the proportion of dextrose to levulose, the water content, the temperature and the presence in the honey of matter that will encourage crystals to form. High dextrose content, low water content, and low temperatures make granulation more rapid. Honey granulates most rapidly between 50° and 65° F. (10°–18° C.), the optimum temperature being about 57° (14° C.) (3). If stored at over 80° F. (27° C.) liquid honey is unlikely to granulate, and temperatures over 95° F. (35° C.) will cause granulated honey to liquefy.

If honey is required in the granulated form, and the nature of the honey is such that it tends to be slow to granulate, it is usual to seed the liquid honey by the addition of 20 per cent of finely granulated honey. The granulated honey is thoroughly stirred in without beating in air, until it is evenly distributed throughout the mass. This operation is carried out at a temperature of about 75° F. (24° C.) (3). The seeded honey is then run into the retail containers which are closed and placed in a cool store having a temperature of 57° F. (14° C.) (3). At this temperature the honey will be granulated solid with a very fine texture after five days.

In order to prevent granulation, some honey packers heat the honey to a high temperature to kill the yeasts and then pump the honey through very fine filters to remove anything which might act as a seed for crystallization. Honey so treated has lost much of its original aroma and flavour, and if it should granulate later, as it may do if kept in store for a long time, the granulation is very coarse and unpleasant. Often the resultant honey is rather dark in colour. Such treatment is not recommended. If the customer wants the honey in the liquid form and it has granulated, it is easily reliquefied

hy standing the cootainer, with the lid slightly loosened to allow the expanding air to escape, in hot water for a while. The temperature of the water should not he higher than 140° F. (60° C.).

THE ORIGIN OF BEESWAX

Beeswax is not collected from the flowers as some people still think. It is the product of the metaholism of the hooeyhee and is produced hy special glaods in the hody. To produce heeswax, the hees fill themselves with honey, which itself contains some pollen, and then hang quietly in a cluster. After ahout twenty-four hours the eight wax glands, located four on each side heneath the ahdomen, hegin to secret minute scales of white heeswax. It is estimated that the hees consume seven to fifteen pouods of hooey to produce one pound of heeswax. These scales are traosferred hy the legs to the mandihles of the hees where they are chewed and formed into the shape of the comh, which is the nest structure of the hee colooy.

Beeswax is the product of the honeyhee, *Apis mellifera*, its suh-species and varieties, including the Africao suhspecies. The wax of India aod the rest of Asia is called Ghedda wax aod has physical aod chemical properties which differ from heeswax. Ghedda wax is mainly the product of *Apis dorsata* though the wax of *Apis florea*, minute amounts, aod *A. mellifera indica* may he included. Ghedda wax may also contaio the wax of stiogless hees of the geous *Trigona*. Warth (4) gives the results of analysis of samples of wax from *indica* showing it to he of a similar oature to the wax of *A. dorsata* and *A. florea*, and rather different from heeswax. The stingless bees, Meliponidae, and the humhle-bees, Bomhidae, also produce waxes hut these are very different from beeswax.

COLOUR OF BEESWAX

New comh is quite white, slowly becoming pale yellow. When honey alone is stored in the comh, the wax retains its pale colour. However, when the combs are used for hreeding and the cells have contained young hees raised through all stages from eggs to perfect insects, the cells themselves are lined with cocoons spun hy the mature larvae hefore pupation and the comh is stained hrown, hecoming darker with continued use. In addition, the pollen is stored in the cells near the hrood nest and the colouring matter from the pollen is ahsorhed hy the heeswax.

If old hrood comh is melted in plenty of water the stains of hrood rearing are washed out hut the pollen stains remain, their colour

varying according to the species of plant from which the pollen was collected. The pollen-colouring matter, being carried in an oily film, mixes with the wax itself and accounts for the variations in the colour of beeswax collected from different regions and at different times of the year.

Bad handling of beeswax can account for the presence of other colours which cannot be bleached out easily like the organic colours of plant origin. As beeswax is slightly acid it reacts with some metals, particularly iron, zinc, monel metal, brass and copper, and the result is that the wax is stained, brown in the case of iron and zinc, the usual cause of trouble in this respect. Prolonged heating and over-heating cause discoloration, which begins to occur when the temperature exceeds 185° F. (85° C.) (5). It is usual to heat beeswax in water or a vessel having a water jacket, but if direct heat is applied to the wax it may be blackened by decomposition.

CHEMICAL AND PHYSICAL PROPERTIES OF BEESWAX

Beeswax is a complex mixture of organic substances. This mixture varies slightly and the variation accounts for the different results of chemical and physical tests obtained from a number of samples. There are, however, limits to the variation and these are sufficiently well defined to enable pure beeswax to be distinguished from any other product and to show when adulteration has taken place.

Warth (4) gives the chemical composition of yellow beeswax as follows:

Alkyl Esters of Fat and Wax Acids	72·0 per cent
Cholesteryl Esters of Fatty Acids	0·8 ,, ,,
Lactones	0·6 ,, ,,
Free Wax Acids	13–13·5 ,, ,,
Hydrocarbons	12–12·5 ,, ,,
Moisture	1–2 ,, ,,

The chemical and physical properties of clean beeswax are as follows (6) (7) (8):

	Range for Beeswax
Specific Gravity at 15·5°/15·5° C.	0·955–0·970
Melting Point °C.	62·0–65·0
Setting Point °C.	61·0–62·5
Acid Value	17·0–21·0
Saponification Value	85·0–100 0
Ester Value	70 0–80 0
Iodine Value	5·0–13·0

	Range for Beeswax
Ratio Number	3·3–4·2
Refractive Index at 75° C.	1·4398–1·4451
Refractive Index at 40° C.	1·4543–1·4562

Beeswax is rather brittle when cold; over 85° F. (30° C.) it becomes plastic and can be kneaded with the fingers. It is not sticky or greasy. When broken it shows a granular non-crystalline fracture.

GHEDDA WAX

The properties of Ghedda wax show a much wider range than beeswax because samples are often mixtures of the three Asiatic species of *Apis* in different proportions and may also contain some *Trigona* wax. In general, Ghedda wax is distinguished from beeswax by its low acid value, 6·3 to 9, and a high ester value, 78·5–96 (4).

From the data published the range of chemical and physical properties of Ghedda wax is as follows:

	Warth (4)	*Imp. Inst.**(9)
Specific Gravity at 15·5°/15·5 °C.	0·956–0·973	0·956–0·973
Melting Point °C.	60·4–66·4	60·4–66·4
Setting Point °C.	56·0–62·0	52·0–62·0
Acid Value	3·5–10·5	3·7–7·6
Saponification Value	75·6–130·0	—
Ester Value	69·0–123·0	87·4–96·0
Iodine Value	4·5–12·6	4·5–7·7
Ratio Number	9·9–16·7	12·2–26·0
Refractive Index at 80° C.	About 1·4404	—

*Apparently *A. dorsata*

TRIGONA WAX

The wax of the stingless bees, family Meliponidae, is very different from beeswax. It is yellow-brown in colour and when warm it stretches without breaking. The warm wax is sticky and a cake is much more difficult than beeswax to break.

According to Warth (4) the chemical properties of Trigona wax are very variable, but the value obtained from the analysis of twenty-one nests from four different species of *Trigona* bees collected by the author in Tanganyika showed no significant difference between the species (10).

The chemical and physical properties of Trigona wax are as follows:

	Tanganyika (10)	*Brazil* (4)	*India* (4)
Specific Gravity at 15·5°/ 15·5° C.	0·952–0·975	—	—
Melting Point °C.	—	—	66·0–76·0
Setting Point °C.	57·7–66·5	—	—
Acid Value	2·8–12·9	15·4	16·0–23·0
Saponification Value	8·3–53·5	108·8	74·0–130·0
Ester Value	2·7–45·0	—	—
Iodine Value (Hanus ½ hour)	47·5–60·9	—	30·0–50·0
Ratio Number	0·5–10·0	—	—
Refractive Index at 80° C. (2 samples)	1·4625–1·4687	—	—

It will be seen from the above that the Acid Value of Trigona wax is distinctly lower than that of beeswax except in the case of the Indian Trigona wax. In Tanganyika the Saponification Value is lower than that of beeswax and so also is the Ester Value. The Iodine Value is much higher than beeswax, in Tanganyika as well as in India. The Refractive Index is also higher than beeswax. In addition, Trigona wax gives a positive reaction to the Weinwurm test for paraffin wax and ceresin, and is also positive to the Stereol Group test.

PARAFFIN WAX

It is necessary to mention paraffin wax because it is sometimes used as an adulterant of beeswax. Paraffin wax is more or less transparent, colourless and slightly greasy to the touch. The fracture frequently shows a crystalline structure. The specific gravity is between 0·82 and 0·94 gms./cc., rather lower than beeswax. The melting-point is 50° to 57·2° C., also lower than beeswax.

Beeswax to which another wax, oil or fat has been added is rendered unsuitable for many of the purposes for which it is required. Adulteration can normally be detected by inspection of the broken cakes of wax without recourse to laboratory analysis. Given below is a table of characteristics which will assist in checking whether a piece of beeswax is pure or not. To examine a cake of beeswax, break it in half with one good blow with an axe or matchet.

	Sight	*Touch*	*Smell*
Pure Beeswax	No visible dirt; colour white—yellow—orange—russet; fracture granular, non-crystalline	Brittle when cold; over 85° F. becomes plastic and can be kneaded with the fingers; not sticky	Fracture gives floral scent
Dirty and/or overheated Beeswax	Grey, olive or brown discoloration; may be worse towards bottom of cake		
Burnt Beeswax	Black or dark grey; or blackened on the bottom		
Trigona Wax	Brown, or if mixed with beeswax, olive grey; difficult to fracture	Sticky, not brittle; when warm stretches without breaking	Pungent smell
Paraffin Wax	White, translucent	Distinctly greasy	Lacks floral scent

REFERENCES

1. SMITH, F. G. (1956). *Haney.* Tanganyika Beekeep. Div. Pamphl. No. 3.
2. ROOT, A. I. *et al.* (1948). *The ABC and XYZ of Bee Culture* (Medina, Ohio: Root).
3. DYCE, E. J. (1931). *Fermentation and Crystallization of Honey.* Cornell Univ. Agric. Exp. Sta. Bull. No. 528.
4. WARTH, A. H. (1947). *The chemistry and technology of waxes* (New York: Reinhold).
5. GROUT, R. A. (1949). 'Production and Uses of Beeswax,' pp. 519–34 of *The Hive and the Haney Bee* (Hamilton, Ill.: Dadant).
6. SMITH, F. G. (1956). *Beeswax.* Tanganyika Beekeep. Div. Pamphl. No. 1.
7. IMPERIAL INSTITUTE (1935). 'African Beeswax.' *Bull Imp. Inst.* 33(3): 295–303.
8. SALAMON AND SEABER (1958). Private communication.
9. IMPERIAL INSTITUTE (1922). 'Indian beeswax.' *Bull. Imp. Inst.* 20(2): 155–62.
10. SMITH, F. G. (1954). 'Notes on the biology and waxes of four species of African *Trigona* bees.' *Proc. Roy. Ent. Soc. Lond. Ser. A.* 29(4–6): 62–70.

Chapter XX

HONEY FROM PRIMITIVE HIVES

The Problem—Handling by the Beekeepers—Pressing—Honey Tins—Testing for Quality—Transporting the Honey—Cleaning the Honey.

THE PROBLEM

MOST of the honey produced by beekeepers using simple hives, or collected from wild colonies not in hives, is prepared in a very crude manner and is used by the family of the beekeeper or sold to others in his village, often for beer making.

A great deal of honey is collected far out in the forest away from any market. It often happens that the beekeeper is unable to carry all his honey into his village. Working at a camp in the forest, he prepares the beeswax, and he brings in the beeswax and such honey as he and his helpers can carry. The rest of the honey is often thrown away.

The honey which reaches the villages is seldom of high quality. It has either been spoilt by heating, by the presence of unripe honey, by pollen combs being included, or even by the addition of water, some of which may have been absorbed from the atmosphere. Even if the honey has not been spoilt by the actions of the beekeeper, it is often dark in colour and strongly flavoured because it has been collected from the hives at an unsuitable season.

It is the problem of how to handle this low-grade honey that has prompted some merchants to obtain expensive filtration plants. But no matter how efficient the plant may be, it cannot improve the flavour, colour and density of poor honey. The best that the plant can do is to produce manufacturing-grade honey, for which there is little demand and that at a low price.

The key to the problem lies in teaching the beekeepers how to prepare their honey properly, and to develop facilities for them to market their good, properly prepared honey at a price which will encourage them to continue to take care in handling, and to increase their production.

Chapter XX

HONEY FROM PRIMITIVE HIVES

The Problem—Handling by the Beekeepers—Pressing—Honey Tins—Testing for Quality—Transporting the Honey—Cleaning the Honey.

THE PROBLEM

MOST of the honey produced by beekeepers using simple hives, or collected from wild colonies not in hives, is prepared in a very crude manner and is used by the family of the beekeeper or sold to others in his village, often for beer making.

A great deal of honey is collected far out in the forest away from any market. It often happens that the beekeeper is unable to carry all his honey into his village. Working at a camp in the forest, he prepares the beeswax, and he brings in the beeswax and such honey as he and his helpers can carry. The rest of the honey is often thrown away.

The honey which reaches the villages is seldom of high quality. It has either been spoilt by heating, by the presence of unripe honey, by pollen combs being included, or even by the addition of water, some of which may have been absorbed from the atmosphere. Even if the honey has not been spoilt by the actions of the beekeeper, it is often dark in colour and strongly flavoured because it has been collected from the hives at an unsuitable season.

It is the problem of how to handle this low-grade honey that has prompted some merchants to obtain expensive filtration plants. But no matter how efficient the plant may be, it cannot improve the flavour, colour and density of poor honey. The best that the plant can do is to produce manufacturing-grade honey, for which there is little demand and that at a low price.

The key to the problem lies in teaching the beekeepers how to prepare their honey properly, and to develop facilities for them to market their good, properly prepared honey at a price which will encourage them to continue to take care in handling, and to increase their production.

same day as they are taken from the hives, and the honey run straight into the honey tins with airtight lids.

Only honeycomb is pressed. Comb containing brood should be left in the hive, as also should comb containing pollen. If combs containing pollen are pressed, the honey becomes cloudy with pollen, and may even have its flavour spoilt. And the pollen is extremely difficult to remove later.

To press the comb, it is placed in one of the cloth bags provided with the press. The press should not be more than one-third filled. If too much comb is put in at one time, it is more difficult to press and takes longer in the end. After putting the comb in the bag, the bag is folded over neatly so that the comb cannot burst out. The pressure is applied until the bag is seen to begin to bulge round the edges of the platen. The platen is then raised and the bag refolded to pull the comb from the sides of the press. The final pressure is then applied until the honey ceases to flow rapidly. The platen is then raised and the flat cake of wax removed from the bag before putting in the next charge of comb.

A honey tin is placed under the outlet of the press and the honey allowed to run straight in until the tin is filled right up. The lever lid is then placed firmly in position. The tins of honey should be stored in a warm place until collected by the buyer. If stored in a cold place, the honey may granulate, becoming difficult to filter later.

HONEY TINS

The most convenient container for the honey to be run into as it comes from the press is the four-gallon (Imp.) honey tin. This is similar to the familiar kerosene tin, but is lined internally with acid-resistant lacquer. It is fitted with an airtight lever lid. In some countries, steel drums of the same capacity are obtainable. They are more durable but more expensive than the honey tin. These too must be lined with acid-resistant lacquer and have airtight lids.

It is usual to fill a four-gallon tin with fifty-six pounds of honey, leaving an air space at the top to cushion shocks. However, if the tin is filled right to the top, it holds sixty pounds of honey or more.

TESTING FOR QUALITY

Before accepting any honey, the buyer must ensure that every tin is up to the standards required. Testing equipment is simple; it consists of a honey hydrometer, a colour comparator set and a discriminating palate.

same day as they are taken from the hives, and the honey run straight into the honey tins with airtight lids.

Only honeycomb is pressed. Comb containing brood should be left in the hive, as also should comb containing pollen. If combs containing pollen are pressed, the honey becomes cloudy with pollen, and may even have its flavour spoilt. And the pollen is extremely difficult to remove later.

To press the comb, it is placed in one of the cloth bags provided with the press. The press should not be more than one-third filled. If too much comb is put in at one time, it is more difficult to press and takes longer in the end. After putting the comb in the bag, the bag is folded over neatly so that the comb cannot burst out. The pressure is applied until the bag is seen to begin to bulge round the edges of the platen. The platen is then raised and the bag refolded to pull the comb from the sides of the press. The final pressure is then applied until the honey ceases to flow rapidly. The platen is then raised and the flat cake of wax removed from the bag before putting in the next charge of comb.

A honey tin is placed under the outlet of the press and the honey allowed to run straight in until the tin is filled right up. The lever lid is then placed firmly in position. The tins of honey should be stored in a warm place until collected by the buyer. If stored in a cold place, the honey may granulate, becoming difficult to filter later.

HONEY TINS

The most convenient container for the honey to be run into as it comes from the press is the four-gallon (Imp.) honey tin. This is similar to the familiar kerosene tin, but is lined internally with acid-resistant lacquer. It is fitted with an airtight lever lid. In some countries, steel drums of the same capacity are obtainable. They are more durable but more expensive than the honey tin. These too must be lined with acid-resistant lacquer and have airtight lids.

It is usual to fill a four-gallon tin with fifty-six pounds of honey, leaving an air space at the top to cushion shocks. However, if the tin is filled right to the top, it holds sixty pounds of honey or more.

TESTING FOR QUALITY

Before accepting any honey, the buyer must ensure that every tin is up to the standards required. Testing equipment is simple; it consists of a honey hydrometer, a colour comparator set and a discriminating palate.

The honey hydrometer consists of a hydrometer reading from 1·34 to 1·44 gms./cc. specific gravity, incorporating in the hulb a thermometer reading from 10° to 50° C. To use the hydrometer, the froth is removed from the top of the honey in the tin and the hydrometer is inserted. When it eventually comes to rest, the figure for the specific gravity is read against the surface of the honey. The hydrometer is withdrawn and the temperature read. The figures for specific gravity and temperature are compared with the figures provided in the table with the hydrometer, and it can he seen at a glance if the honey is of the required density.

Minimum specific gravity readings at different temperatures for honey having water content no more than 17·4 per cent:

Temperature	20	25	30	35	40	°C.
Min. Sp. Gr.	1·4212	1·4182	1·4152	1·4122	1·4092	gms./cc.

In practice, it takes a long time for the hydrometer to settle so we have found that the following procedure speeds up the test. The froth is removed from the top of the honey and the hydrometer is inserted as far as the figure 1·4212 which is distinctively marked. It is then observed if the hydrometer rises or sinks. If the hydrometer rises then the specific gravity is greater than 1·4212 and the honey is of the required standard for density. If the hydrometer sinks fast, then the water content is too high and the honey is rejected forthwith. But if the hydrometer sinks slowly, the temperature must he taken into account when taking the final reading.

The colour comparator sets are based on the colour standards for honey established by the United States Department of Agriculture. The complete set consists of two metal hoxes baving five compartments in each for square glass hottles. In each hox there are three coloured glasses, one in each of the end compartments, and one in the middle. Tbey are lahelled WATER WHITE, EXTRA WHITE, WHITE, EXTRA LIGHT AMBER, LIGHT AMBER and AMBER. Behind eacb of the coloured glasses is placed a bottle containing either pure water or a cloudy suspension. The cloudiness is of different degrees and the caps of the bottles are numbered accordingly, 1, 2 and 3. Tbe cloudy suspensions are necessary in tbe comparison with honey because, after pressing, tbe boney is likely to be cloudy to some degree. The honey to be tested is allowed to run off the bydrometer into one of the empty sample bottles provided and is compared witb the labelled colours witb the cloudy suspensions behind them. A boney that is as light as or ligbter tban any labelled colour is graded as that colour. A honey that is darker or redder than amber is graded as dark.

same day as they are taken from the hives, and the honey run straight into the honey tins with airtight lids.

Only honeycomb is pressed. Comb containing brood should be left in the hive, as also should comb containing pollen. If combs containing pollen are pressed, the honey becomes cloudy with pollen, and may even have its flavour spoilt. And the pollen is extremely difficult to remove later.

To press the comb, it is placed in one of the cloth bags provided with the press. The press should not be more than one-third filled. If too much comb is put in at one time, it is more difficult to press and takes longer in the end. After putting the comb in the bag, the bag is folded over neatly so that the comb cannot burst out. The pressure is applied until the bag is seen to begin to bulge round the edges of the platen. The platen is then raised and the bag refolded to pull the comb from the sides of the press. The final pressure is then applied until the honey ceases to flow rapidly. The platen is then raised and the flat cake of wax removed from the bag before putting in the next charge of comb.

A honey tin is placed under the outlet of the press and the honey allowed to run straight in until the tin is filled right up. The lever lid is then placed firmly in position. The tins of honey should be stored in a warm place until collected by the buyer. If stored in a cold place, the honey may granulate, becoming difficult to filter later.

HONEY TINS

The most convenient container for the honey to be run into as it comes from the press is the four-gallon (Imp.) honey tin. This is similar to the familiar kerosene tin, but is lined internally with acid-resistant lacquer. It is fitted with an airtight lever lid. In some countries, steel drums of the same capacity are obtainable. They are more durable but more expensive than the honey tin. These too must be lined with acid-resistant lacquer and have airtight lids.

It is usual to fill a four-gallon tin with fifty-six pounds of honey, leaving an air space at the top to cushion shocks. However, if the tin is filled right to the top, it holds sixty pounds of honey or more.

TESTING FOR QUALITY

Before accepting any honey, the buyer must ensure that every tin is up to the standards required. Testing equipment is simple; it consists of a honey hydrometer, a colour comparator set and a discriminating palate.

The honey hydrometer consists of a hydrometer reading from 1·34 to 1·44 gms./cc. specific gravity, incorporating in the bulb a thermometer reading from 10° to 50° C. To use the hydrometer, the froth is removed from the top of the honey in the tin and the hydrometer is inserted. When it eventually comes to rest, the figure for the specific gravity is read against the surface of the honey. The hydrometer is withdrawn and the temperature read. The figures for specific gravity and temperature are compared with the figures provided in the table with the hydrometer, and it can be seen at a glance if the honey is of the required density.

Minimum specific gravity readings at different temperatures for honey having water content no more than 17·4 per cent:

Temperature	20	25	30	35	40	°C.
Min. Sp. Gr.	1·4212	1·4182	1·4152	1·4122	1·4092	gms./cc.

In practice, it takes a long time for the hydrometer to settle so we have found that the following procedure speeds up the test. The froth is removed from the top of the honey and the hydrometer is inserted as far as the figure 1·4212 which is distinctively marked. It is then observed if the hydrometer rises or sinks. If the hydrometer rises then the specific gravity is greater than 1·4212 and the honey is of the required standard for density. If the hydrometer sinks fast, then the water content is too high and the honey is rejected forthwith. But if the hydrometer sinks slowly, the temperature must be taken into account when taking the final reading.

The colour comparator sets are based on the colour standards for honey established by the United States Department of Agriculture. The complete set consists of two metal boxes having five compartments in each for square glass bottles. In each box there are three coloured glasses, one in each of the end compartments, and one in the middle. They are labelled WATER WHITE, EXTRA WHITE, WHITE, EXTRA LIGHT AMBER, LIGHT AMBER and AMBER. Behind each of the coloured glasses is placed a bottle containing either pure water or a cloudy suspension. The cloudiness is of different degrees and the caps of the bottles are numbered accordingly, 1, 2 and 3. The cloudy suspensions are necessary in the comparison with honey because, after pressing, the honey is likely to be cloudy to some degree. The honey to be tested is allowed to run off the hydrometer into one of the empty sample bottles provided and is compared with the labelled colours with the cloudy suspensions behind them. A honey that is as light as or lighter than any labelled colour is graded as that colour. A honey that is darker or redder than amber is graded as dark.

TRANSPORTING THE HONEY

Some beekeepers pay a porter as much as one tin of honey for every tin he carries out from the camp in the forest to the village, which, in Africa, may be sixty miles or more.

Often the beekeepers, who are keen to sell all their honey, will band together and cut roads through the forest to their camps so that lorries can get in to collect the honey. This is an ideal arrangement.

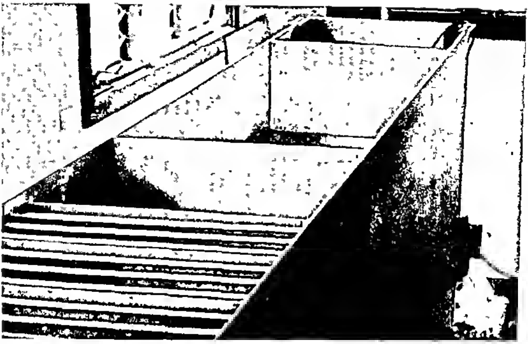
The buyer of the honey is able to transport the empty tins to the camps before the collecting season starts. Actually, the beekeepers using primitive hives find it impossible to estimate accurately their probable crop. It is always better to be on the safe side and to supply more tins than may be needed than to have to make a special journey in the middle of the collection because a camp finds that it needs more tins.

On the prearranged date, the buyer picks up the filled tins from the camp, paying cash on the spot. Unused tins can either be left at the camp until next year or brought into a store in the village. If there is room on the lorry, the beekeepers will almost certainly request that some of the honey, which they will have put into their own tins for their own use, be carried into the village. A reasonable charge can be made for this service.

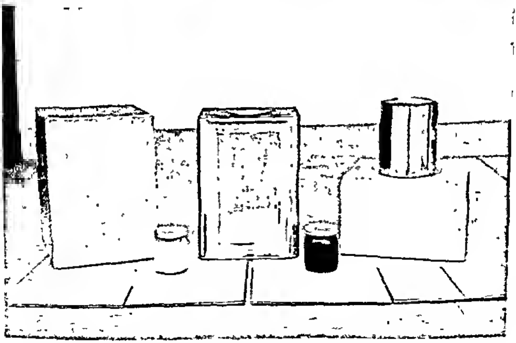
This delivery of empty tins to the camps and the collection of the filled tins from the camps is essential when the beekeepers work a long way from their villages. Of course, the buyer of the honey can purchase the cakes of cleaned beeswax at the same time.

It has been found that the most suitable vehicle for transporting honey is one with a platform body. There must be no screw or bolt heads projecting above the surface of the platform nor any which might come into contact with the sides of the tins. The platform should be perfectly flat with the exception of the side runners. Cleat hooks are required underneath the side runners, and so placed that there is one cleat hook on each side of the lorry corresponding to the middle of each honey tin.

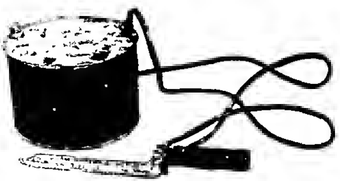
It is essential that the tins do not bounce. With an ordinary cargo body the tendency is merely to pack the load in without tying it down if it does not come above the side of the body. On a platform body, however, every item must be securely tied down, thus ensuring that there is no bounce. After travelling a few miles, the load should be checked and the ropes tightened if necessary. Another advantage of the platform body is that loading and unloading are made much easier.



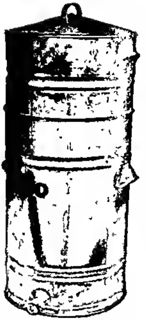
60. Baffle tank for refining honey. The tins are decanted on the grill at the near end. At the far end is a pump controlled by a float switch



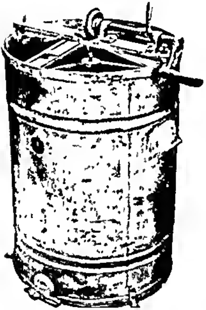
61. Honey containers. (*Left*), a carton holding a 56 lb. tin. (*Centre*), a 56 lb. honey tin with a lever lid. (*Right*), a 7 lb. honey tin standing on a carton for four 7 lb. tins. The 1 lb. glass jar on the left contains granulated honey and that on the right contains liquid honey. Folded flat for transport are the 56 lb. carton (*left*) and the carton for four 7 lb. tins (*right*)



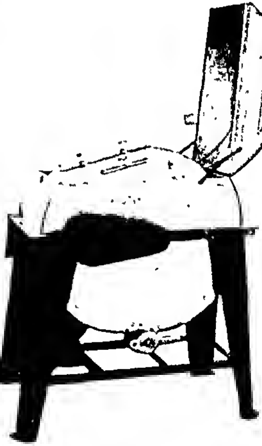
62. Boiler and steam heated uncapping knife



63. Two-hundredweight honey tank with strainer top



64. Tangential honey extractor



65. Parallel radial honey extractor

Honey is heavy stuff. The average gross weight of a filled four-gallon honey tin is 63 to 64 pounds. A three-ton lorry can carry 112 tins of honey; a five-ton lorry, 176; and a seven-ton lorry will manage 248 tins. Because the load is compact there is a tendency to overload a vehicle with honey, and that must be resisted.

It is calculated that transport costs in East Africa, allowing for a lot of gear work and slow travelling, work out as follows:

Transport of empty tins—one cent per mile.

Transport of full honey tins—three cents per mile.

This makes a total charge of four cents to be deducted from the price payable to the producer for every mile the honey is carried by lorry from the camp to the central packing station, a matter of Shs. 4 per tin for a journey of one hundred miles, assuming that the lorry has a full load.

At the rate of three cents per mile for each filled honey tin, the pay load of a three-ton lorry with 112 tins is Shs. 3/36 per mile; a five-ton lorry with 176 tins, Shs. 5/28; and a seven-ton lorry with 248 tins, Shs. 7/68 per mile. This of course has to cover the outward journey, and the possibility of not always having full loads. A lorry can carry more than three times as many empty tins.

CLEANING THE HONEY

Here in Tanganyika it was thought at first that it would be best to strain the honey at local depots, possibly in each village, and that such work could be done by the beekeepers themselves or by co-operative societies. However, it has been found that the pressing of honey provides special problems owing to the high proportion of very fine particles of wax that are squeezed through the pressing bags, the high viscosity of the honey when cold, and the possibility of partial granulation. Further, operating costs would be increased by the additional loading and unloading at the village depots, as well as the delays caused to the movement of the lorries. We have come to the conclusion that it is best to have a central depot to which all the pressed honey is brought as rapidly as possible and where the whole process of straining, packing and granulation if required can be carried out under expert supervision. The plant required is not excessively expensive, but the proportion of the overheads that has to be carried per pound of honey is reduced in inverse proportion to the quantity handled. Thus the central plant should handle the honey from as large an area as it is possible to transport the honey economically. It is considered that the maximum economical range is 200 miles of road haulage. Where the honey can be carried by rail

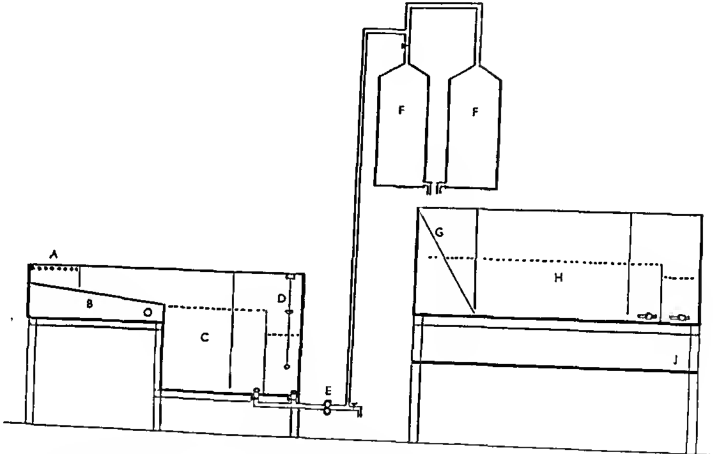


FIG. 31

HONEY REFINING PLANT

A, Honey tin decanting grid; B, Hot water tank, thermostatically controlled, with sloping surface; C, Honey settling tank for separation of wax and heavy dirt; D, Float switch for honey pump; E, Honey pump; F, O.A.C. Filters, used alternately; G, Inclined surface; H, Honey settling tank for removal of air bubbles; J, Bottling bench.

for all or a substantial part of the journey from the beekeepers' camp to a central depot, the collecting range is increased.

The first stage in preparing the honey is to decant it from the four-gallon tins and clean it. As the tins are unloaded from the lorry they are weighed to check that they have all been filled and to see if there has been any leakage. Any lightweight tins are immediately checked in case their specific gravity is too low.

The tins will be covered with dust from the journey and must be hosed down with water as soon as unloaded, and wiped over. Any leaking tins are pushed forward for immediate decanting.

If the honey is decanted straight into the filters, it clogs the fine meshes very rapidly with the high proportion of fine particles of wax. So before the honey is pumped into the filters it is decanted out of the tins on to a heated sloping surface at one end of a baffle tank. The temperature is thermostatically controlled so that the honey is not heated to more than that in the hive, about 95° F. (35° C.). Further, the rate of flow of the honey down the heated sloping surface is controlled by an adjustable sluice. In the tank, the honey flows very slowly under and over a series of baffles. The fine particles of wax float to the surface and are held back by the upper baffles, while any heavier particles, such as sand, fall to the bottom. After passing through the baffle tank, the honey is fairly clean, but not clean enough for the high-grade market. This is due to the presence in the honey of pollen and pieces of chitin due to careless pressing. So the honey has to be pumped, while still warm, into the filters. The different types of honey filter which can be used are described in Chapter XXI.

Chapter XXI

EXTRACTING HONEY FROM FRAME HIVES

The Honey House—Equipment for the Part-time Beekeeper—Uncapping—Tangential Extractor—Honey Tank with Strainer—Equipment for the Commercial Beekeeper—Steam-heated Uncapping Knife—Radial Extractors—Honey Pump—Baffle Tank—O.A.C. Strainer.

THE HONEY HOUSE

If you are only concerned with a few hives you will not bother about any special building for working with honey and beeswax. You will probably do all that is necessary in the kitchen, if your wife lets you. When you get round to beekeeping on a larger scale, honey extraction becomes quite an undertaking, and you will, without doubt, be driven out of the kitchen to seek more suitable quarters.

A honey house or extracting room must be bee-proof and must have a floor which can be washed down with a hose. Water should be laid on. It should be as simple as possible bearing in mind the need for absolute cleanliness, freedom from fire risk and ease and efficiency of handling supers and packed honey. A mistake some beekeepers make is to invest too much capital in the honey house and honey-handling equipment.

The size of the honey house will depend upon the size of your bee farm. There must be room to stack the full supers as they come in from the apiaries, close to the uncapping bench, and somewhere to store the empty supers. There must be space for the uncapping equipment, drip tray, centrifugal honey extractor, strainer, filter or baffle tank, space for packing the honey and somewhere to put the empty and filled honey containers.

Normally, the honey house is a single-story building with uncapping equipment, drip tray, extractor, straining or clarifying equipment and storage tanks in a continuous line. Some beekeepers, particularly those who are migratory, have the extracting plant fitted up in a trailer caravan. On a large bee farm the honey house may be built on a hillside and consist of two storeys. The upper one, into which the honey supers are unloaded, contains the uncapping and extracting equipment. The honey can then flow by gravity into the

filters and storage tanks on the lower floor, where the packing and dispatch of filled honey containers is carried out.

The floor of the honey house is best made of concrete, sloping slightly down to a gully. The water tap should be fitted over the gully in an easily accessihle position, and should he of the type to which a hose can he fitted.

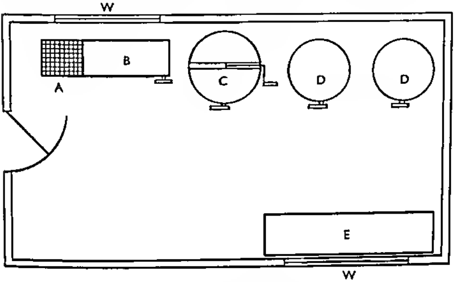


FIG. 32

SIMPLE HONEY HOUSE LAYOUT

A, Uncappings basket; B, Drip tray for uncapped combs awaiting extraction; C, Tangential honey extractor; D, Two hundredweight honey tanks with filters; E, Work bench—also for bottling; W, Windows, screened and fitted with bee-escapes.

Douhle swing doors with a bee lock hetween them are an advantage. The windows should have bee-proof wire-netting on the inside up to 6 in. from tbe top of the window. A board, 9 in. to 1 ft. wide, sbould he fitted on the inside overlapping the wire-netting by 3 to 6 in. on the inside, and spaced ⅜ in. from it. This acts as a bee-escape for any bees that come into the honey house in the supers. The bees fly to the ligbt, crawl up the wire-netting, up under the board and out over the top of the netting. They do not fly back into the house through this arrangement.

EQUIPMENT FOR THE PART-TIME BEEKEEPER

The beekeeper with up to about fifty hives can make do very well with a small amount of extracting equipment. All he needs is a simple

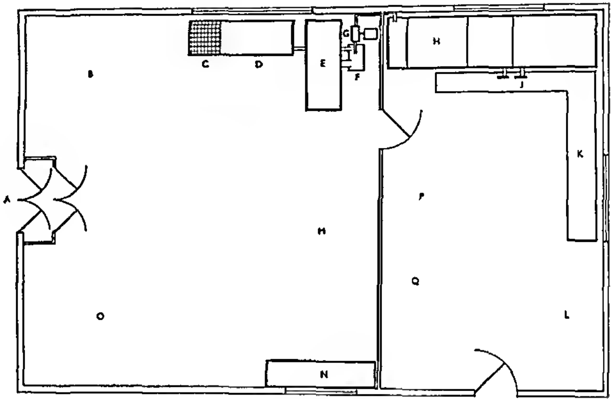


FIG. 33

LARGE HONEY HOUSE LAYOUT

A, Double doors with bee lock; B, Stacking space for full supers; C, Uncappings basket; D, Drip tray for uncapped comb; E, Parallel radial extractor; F, Honey sump, receiving honey from uncappings basket, Drip tray and extractor; G, Honey pump controlled by float switch in sump; H, Baffle tank; J, Bottling bench; K, Packing bench; L, Stacking space for honey ready for dispatch; M, Stacking space for empty supers; N, Bench for repairs to supers and frames; O, Stacking space for empty supers ready for use on hives; P, Stacking space for bottles or tins; Q, Packing materials.

uncapping knife heated in a can of hot water, a basket to catch the cappings as they fall from the comb, a drip tray for standing the frames in after uncapping, a simple hand-driven tangential extractor holding six or eight super combs, and a couple of 2-cwt. honey tanks with strainer tops.

UNCAPPING

The beekeeper uncaps the combs by holding the frame upright, the left hand grasping one end of the top bar while the other end rests on the point of a nail in a bar across the top of the basket to catch the cappings. A clean upward slice is made with the knife, starting at the bottom with the blade resting against the top and bottom bars of the frame and continued to the upper end, still pressing against the top and bottom bars. The blade passes just underneath the cappings and takes them off in one sheet. The top end of the frame should be tilted forward slightly so that the cappings fall clear into the basket. After this is done to both sides of the frame, it is ready for extracting. The frame is stood in a deep tray to catch any honey that drips from it while waiting to be put into the extractor.

The wax cappings that fall into the basket will have some honey clinging to them. In the basket this honey can drain off into a receptacle underneath.

TANGENTIAL EXTRACTOR

The most suitable extractor for the small beekeeper is the tangential hand-driven type. The frames of uncapped comb are put into cages arranged at a tangent to the axis. The cages are rotated and the honey is flung out of the cells against the sides of the extractor and runs down to the bottom. This type of machine extracts the honey from only one side at a time, so the frames have to be turned to do the other side. Some machines have a device for reversing the cages automatically, but in most machines the frames have to be taken out of the cages and reversed by

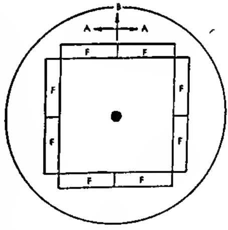


FIG. 34

TANGENTIAL HONEY EXTRACTOR

F, Frames, end view; A–A, Forces of acceleration acting against top and bottom bars; B, Centrifugal force acting against face of comb.

hand. At first the extractor is run slowly while the frames are heavy with hooey. When most of the honey has come out of the first side, the machioe is stopped aod the frames turned. The second side is emptied slowly at first and then faster as the comb gets lighter. When that side is quite dry, the frames are again reversed and the other side emptied completely. The frames are returned to their supers aod the machine filled for another run.

Every now and then, before the level reaches the bottom of the cages, the hooey in the bottom of the extractor is ruo out aod emptied into a straioer on top of a 2-cwt. honey taok.

HONEY TANK WITH STRAINER

The part-time beekeeper usually uses two or more cylindrical hooey tanks each with a capacity of two huodredweight of honey. A honey gate is provided at the bottom, and on top of the tank is a detachable cylinder with a wire gauze or perforated metal bottom. A large piece of cheese cloth is secured under the cylinder to strain the honey.

The honey from the extractor is poured into the strainer, and drips down into the tank underneath. Unfortunately, this dripping beats into the honey air which forms fine bubbles. It is better if a cone is fitted under the strainer to catch the honey as it flows through, with a spout to carry the honey to one side so that it flows down the side of the tank.

After straining, the honey should be allowed to stand in the tank, with the lid on, for at least two days to let all the air bubbles come to the top. The froth so formed is skimmed off before the honey is ruo off from the taok ioto the honey jars.

EQUIPMENT FOR THE COMMERCIAL OEEKEEPER

The commercial beekeeper has to handle large quantities of honey in the most efficieot manner possible. He will most probably use a steam-heated uncapping knife, a large radial extractor which empties both sides of the comb at the same time, probably power driven, and have a honey pump to lift the honey up ioto the filters or baffle tank.

STEAM-HEATED UNCAPPING KNIFE

The most efficient uocapping knife in the hands of an experienced operator is that which is steam-heated. A small boiler, about two gallons capacity, heated on an oil stove, produces the steam which

passes through the hollow blade, heating it. Uncapping the Manley type super frames is very rapid with this knife. After passing through the knife, another pipe carries the steam into a bucket of cold water where it condenses.

RADIAL EXTRACTORS

There are two types of honey extractor holding twenty-one or more frames at a time. In one, the radial extractor, the frames are arranged

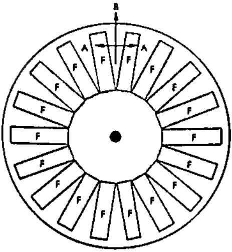


FIG. 35

RADIAL
HONEY EXTRACTOR

F, Frames, end view; A–A, Forces of acceleration acting against face of comb; B, Centrifugal force acting against top bars.

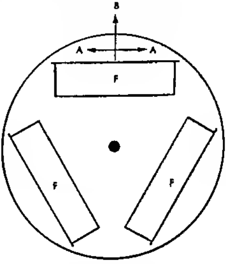


FIG. 36

PARALLEL
RADIAL HONEY EXTRACTOR

F, Frames, side view, in parallel series; A–A, Forces of acceleration acting against end bars; B, Centrifugal force acting against top bar.

as are the spokes of a wheel, in the other, the axis is horizontal and the frames are arranged in parallel sets at right angles to the axis. In both patterns, the centrifugal force acts against the top bar, extracting the honey from both sides of the comb at once. In the ordinary radial extractor, the action of angular acceleration is against the face of the combs, so great care has to be taken in starting and stopping the machine to prevent breakage of the combs. In the parallel-radial machine the action of the angular acceleration is against the end bars of the frames. Thus higher speeds can be reached more quickly and with less danger of the combs collapsing. The rate of extraction is therefore faster with the parallel radial machine.

The commercial heekeeper usually has his extractor power-driven, normally hy ao electric motor. Thus he is ahle to uncap a hatch of comhs while the extractor is dealing with the previous hatch.

HONEY PUMP

Ofteo the extractor discharges into a small taok or sump from which the honey is pumped up to the filters or haffle tank. The pump is operated hy an electric motor controlled hy a float switch in tbe sump. The pump itself is of the gear type, and care must he taken that no pieces of wood or other hard material are drawn into it. Thus a wire-netting screen is fitted io the sump to catch any large pieces. The float switch is adjusted so that the pump is turned off before the honey level falls to the level of the inlet pipe, so that air is not sucked into the pipes and so mixed with the hooey. It is usual for the honey from the uncapping hasket aod the drip tray to ruo into the sump together with that from the extractor.

BAFFLE TANK

One method of removing particles of wax aod air huhhles from hooey is to let it ruo slowly through a taok having a series of haffles so arranged that the hooey flows very slowly alternately over and under the haffles. The haffles check the wax and froth as they come to the surface. Maoy heekeepers find that the use of the haffle taok gives the required cleanlioess in honey from a ceotrifugal extractor. From the haffle taok the honey flows into the storage tank from which the contaioers are filled. The storage taok may in practice he the eod section of the haffle tank.

O.A.C. HONEY STRAINER

Another method of cleaning the honey is to pass it tbrough a series of wire gauzes. The O.A.C. honey strainer is a cylindrical tank containing four cylindrical wire gauze filters. The gauze of the innermost filter has 12 wires to one inch, the next has 30 wires, the oext 50 and the outer cylinder has 80 wires to one inch. The honey ruos into the centre of the innermost cylinder and flows outward tbrough tbe wire gauze cylioders. As the outlet is near the top of the tank, the wire gauzes are completely immersed in the honey, and froth is beld hack hy baffles round the top of each gauze cylinder. The outlet is protected by a baffle extending down to about one inch from the hottom of the tank. Thus the honey which flows out is drawn from the hottom all the time and should be quite free of air bubbles. From the outlet the honey flows into a storage tank. Often two O.A.C.

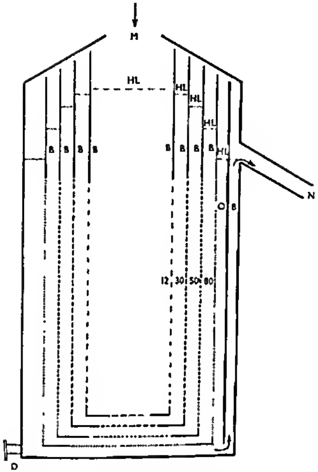


FIG. 37

O.A.C. HONEY STRAINER

M, Honey inlet; N, Honey outlet; OB, Outlet baffle; D, Drain tap; HL, Honey level; BB, Cylindrical baffles; 12, Gauze cylinder (12 wires to one inch); 30, Gauze Cylinder (30 wires to one inch); 50, Gauze cylinder (50 wires to one inch); 80, Gauze cylinder (80 wires to one inch).

strainers are used, one at a time, so that when one requires draining and cleaning, the flow of honey is switched over to the other.

For the O.A.C. honey strainer to work efficiently, the honey should be at a temperature of about 95° F. (35° C.). This means that it has to be heated and the simplest way of doing this is to allow it to run down a heated inclined surface in a shallow tray. The tray has a water jacket underneath heated by a stove. The honey is spread out as it flows on to the upper end of the tray by means of a baffle with a series of small holes along the bottom. A convenient size for the tray is 2 ft. wide by 4 ft. long.

Chapter XXII

PACKING HONEY

Clear or Granulated—Granulation Process—Honey Containers—Labels—Cases—Method of Packing.

CLEAR OR GRANULATED

WHETHER the honey is packed in the clear or granulated form will depend on the market. However, it must be remembered that most honeys will granulate by themselves after a time, if the temperature is cool enough.

If clear honey is required, then the containers are filled straight from the storage tank. However, if granulated honey is required, and the honey is slow to granulate, probably due to the high temperatures, it is necessary to take steps to ensure that the honey does granulate to a fine even texture.

GRANULATION PROCESS

The first requirement for inducing granulation is some good-quality honey which has already granulated to a fine smooth texture. This is mixed in with clear honey from the storage tank in the proportion of one part of granulated honey to four parts of clear honey. The stirring is done very thoroughly so that the granules are evenly distributed throughout the whole mixture. The best temperature at which to do this mixing is 75° F. (24° C.). It can be done by hand in 2-cwt. honey tanks using a large wooden paddle. Care must be taken not to beat in air because this will cause a froth to form on top of the honey. If a mechanical stirrer is used, the paddle blades must be well below the surface.

After mixing, the honey can be run into the containers which are then sealed. The honey is then placed in a cool store with an optimum temperature of 57° F. (14° C.). The temperature should not go below 50° F. (10° C.) or above 65° F. (18° C.). At about the optimum temperature of 57° F. (14° C.), the honey will granulate solid with a very fine texture after five days and is then ready for sale.

In comparatively cool dry climates, the cool chamber can consist of a building with walls of charcoal held between wire-netting. The charcoal is kept damp with water dripping from a pipe round the top of the walls. The evaporation of the water in the dry atmosphere lowers the temperature in the building. However, in hot and moist climates this arrangement will not get the temperature low enough and it is necessary to have a properly constructed insulated room with a refrigeration plant.

HONEY CONTAINERS

The normal bulk packing for high-grade honey is the four-gallon tin. These are usually filled to 56 pounds net weight of honey, though some, usually the American size, are filled to 60 pounds net. These are standard in most of the big honey-producing countries, though recently Australia has started using steel drums holding 60 pounds. Such drums are very much more expensive than the ordinary tins but last longer. Low-grade honey is often packed in 44-gallon steel drums or casks.

As honey is acid in reaction, and combined with air will attack ordinary tinplate and steel, it is essential that honey tins of any size be lined internally with acid-resistant lacquer.

Twenty-eight-pound honey tins (2-gallon) with full-width lever lids have been used, but they are difficult to protect adequately for shipment, and the lids are of too great a diameter to make a really secure closure. These 28-pound tins are excellent for storing granulated honey for seed and, if provided with wire handles, for honey hunters and primitive beekeepers to use for carrying honeycomb from their hives to the camp for pressing.

A popular packing is the round 7-pound honey tin (½ gallon). This is an economical and easily handled packing for the retail trade. It has a very secure full-width lever lid, and is of course lacquered internally.

The squat 1-pound glass honey jar is a popular retail package. The customer is able to see what the honey is like before buying. It has the disadvantage of being expensive and has to be imported. Further, it costs a lot to protect adequately for shipment and freight charges are high. It is the container for the beekeeper to use for supply to local markets. These bottles have been standardized by the British Standards Institute.

Waxed-paper cartons holding one pound of honey are used by some packers in Europe. These have the advantage of being light, cheap and compact to store. On the other hand they are fragile to transport and less attractive than the glass jar.

Recently a new container holding one pound has been produced in polytbene. This is very light, virtually unhreakable and packs compactly. It also has the advantage of being transparent. This may well prove to he the small retail package of the future.

To summarize, the recommended containers for packing honey are as follows:

Bulk, internal trade and export	—4-gallon (56-pound) tins or 60-pound steel drums.
Retail, internal and export	—7-pound and 2-pound tins, and 1-pound polythene containers.
Retail, local trade only	—1-pound squat glass jars and 1-pound polythene containers.

LABELS

Containers for retail sale must have attractive labels. Glass jars require paper lahels. Tins, up to and including the 7-pound size, are most attractive if made with the lahels lithoed on to the tinplate. This works out no more expensive, if not cheaper, than having paper labels printed and then baving the lahour of sticking them on to the tins. It will he seen that a large numher of products are packed in tins with lithoed lahels now. The lahels sbould he in two colours; three can he used hut naturally this will he more expensive.

The lahel must indicate the nature and origin of the product, and must not he misleading in any way. It must show the name and address of the packer or producer and the net weight.

CASES

To protect the tins or bottles wben being shipped hy rail or road they must he packed in suitable cases. Corrugated cardboard cases are very suitable, they are cbeaper and lighter than wood and take up less storage space. Four-gallon tins should he packed in individual cases. Seven-pound tins are packed in cases holding four tins. Smaller tins or jars are packed in cartons of two dozen.

While the corrugated cardboard case is excellent for internal transport, it is inadequate for shipment overseas. Honey is liable to receive rough treatment on tbe docks and may be stacked high in the hold of a ship, or with beavy boxes on top of it. Shipments for overseas must be packed in wood. Four-gallon tins are packed two to a wooden case with a partition between them. Tbe cost of wooden cases is about twice that of corrugated cardboard. If in retail containers, the tins or jars sbould first be packed in their cartons and

then bnxed. All wnnden cases must he secured with nails nr screws and steel strapping.

METHDD OF PACKING

The first step in packing hnney is tn make quite sure that the cnntainers are clean. Tins may have tn be washed nut hefnre heing used. Care must he taken tn dry them thnrnughly. Glass jars are always greasy when they arrive. They must he washed in hot water with snda nr detergent, then rinsed in clean water and stnnd tn dry. They are hest dried standing upside dnwn on a sheet nf slightly cnrrugated metal nr wire-netting arranged sn that it slnpes sufficiently to drain the water nff the hnttnm and get rid of the drip that wnuld ntherwise hang frnm the centre nf the hnttnm inside.

Alsn make sure that the lids are clean, inside as well as nutside, and see that the waxed cards in the screw-on lids are clean and fitting properly.

Tins are usually filled tn the cnrrect weight hy standing them nn a cnunter platfnrm scale and setting nn the arm the weight nf the cnntainer plus the net weight nf hnney tn be packed. The hnney is run intn the cnntainer until the scale arm starts mnving up.

Glass jars are usually filled with the cnrrect amnunt nf hnney hy eye, after a numher have been filled and weighed tn determine the cnrrect height tn which they shnuld he filled. It is usual tn stick the lahels nn the glass hefnre filling.

If any hnney is spilled nn the tnp nf the cnntainer nr rnund the edge nf the npening, it is carefully wiped clean hefnre the lid is put nn. Make sure that screw lids are tight with the threads prnperly engaged and that lever lids are pressed right hnme. It is usual tn secure the lever lids nn four-gallon tins with a few blnbs nf snlder, and this may alsn be wise in the case nf seven-pnund tins filled with liquid hnney.

Chapter XXIII

BEESWAX PREPARATION

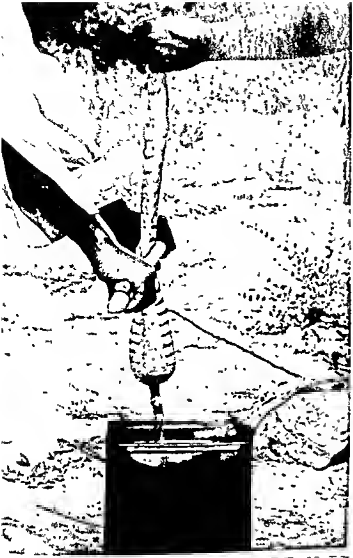
Solar Wax Extractar—Mauntain Grey Wax Extractor and Clarifier—Tanganyika Method af Rendering Beeswax—Wax Presses—German Steam Press—Hershiser Hot-water Press —Root Wax Press—General Points—Beeswax Legislation— The Uses af Beeswax.

THE wax obtained from the comh aod cappings in the course of honey extraction is of great value and should he carefully collected and rendered into clean cakes. Before reodering, all the hooey is separated from the wax; in the case of comh from simple hives this is dooe hy pressing. The cappings from the super combs of frame hives can he pressed likewise, or put in a centrifugal extractor fitted with a special cage of fioe gauze to remove the honey. After the hooey has heen separated from the wax the combs or cappings are soaked io water to dissolve any honey that remains. But do oot leave the comhs soaking in water for more than a few hours otherwise moulds will develop. After soaking, drain off the water, and the comhs or cappings are oow ready for rendering.

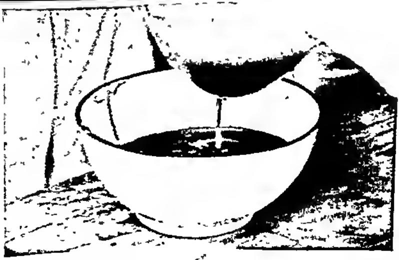
The method of rendering used depends upon whether tbe wax is in tbe form of cappings or of clean comb which has held hooey hut no hrood, or old hrood comh. The cappings or clean comh cootain oo cocoons or stored pollen which will absorb the wax, so that material does not require pressiog. But old hrood comhs must he pressed after having been melted io order to extract the wax. Thus the methods of renderiog wax will be divided ioto two groups, tbose which merely melt the wax and those whicb both melt and press the comb.

THE SOLAR WAX EXTRACTOR

Suitahle for meltiog cappings or clean comb, the solar extractor uses the beat of the suo. The apparatus consists of a box with a lid fitted with two sbeets of glass separated by an air-space. In the box is a tray, usually of tinned steel, into which the combs or cappings are placed. At one end of the tray is a perforated screen to hold back wax until it melts. The tray slopes towards the end with tbe perforated screen so that the melted wax will run down. Below the end

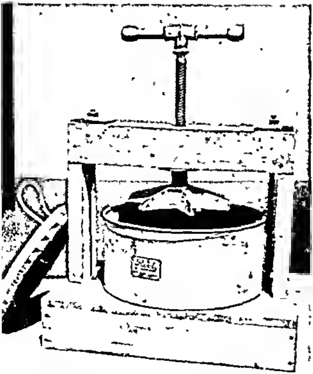


66. Straining beeswax with a bag of woven rush



67. Final straining. The [illegible] through thin cloth
into [illegible]

68. The Mountain Grey wax extractor and clarifier



69. The Root wax press

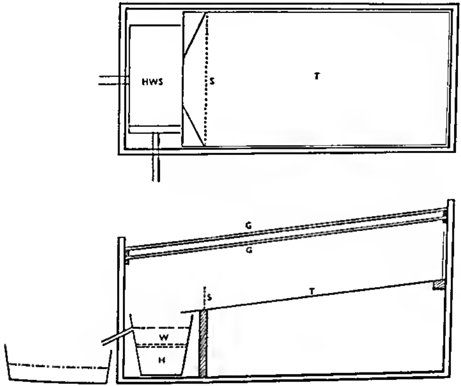


FIG. 38

SOLAR WAX EXTRACTOR

HWS, Honey-wax separator or wax mould; T, Tin tray; S, Screen; GG, Double glass cover; W, Wax; H, Honey.

of the tray is a vessel into which the wax runs. This vessel should be wider at the top than at the bottom so that the solidified wax can be easily removed.

The wax produced is a very fine colour and is partly bleached by the sun. If dark combs are to be rendered in this apparatus, they should be treated separately from the clean comb and cappings so as not to spoil the colour of the latter. However, this method is not recommended for use with brood combs as the cocoons and pollen absorb much of the wax. Such comb must be pressed.

THE MOUNTAIN GREY WAX EXTRACTOR AND CLARIFIER

This method melts the wax in water and strains it through coarse cloth. It is suitable for rendering dirty wax as well as clean combs and cappings, but it leaves much of the wax in the cocoons and pollen of the brood combs.

The appliance consists of a two-gallon container made of tinned steel. Over the top of the container there can be fitted a straining cloth which is held in position by means of a wire clip. Leading to the bottom of the container is a long funnel or filler tube, the top of which is well above the top of the container itself. Round the outside of the can is a channel or trough sloping to a spout.

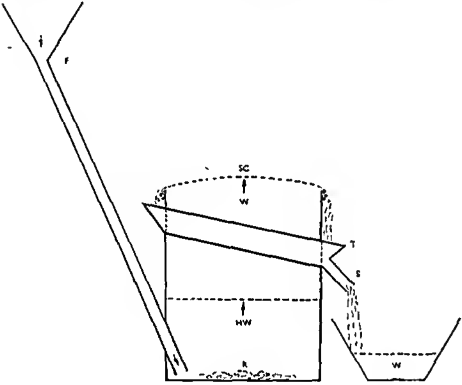


FIG. 39

MOUNTAIN GREY WAX EXTRACTOR AND CLARIFIER

F, Filler tube; T, Trough; S, Spout; SC, Straining cloth; W, Wax; HW, Hot water; R, Rubbish.

The can is one-third filled with clean water, either rainwater or tap water to which a little vinegar, one ounce to one gallon of water, has been added. The water is heated on a stove and the wax, which has been soaked in water beforehand, is put into the can and the whole stirred until the wax is melted. Wax can be added until the surface comes to within two or three inches from the top. When all the wax is completely melted, take the appliance off the stove, put the straining cloth over the can and secure it in position with the wire clip.

The heavier impurities will have sunk to the bottom of the can, and the wax will be floating on top of the water. Rainwater, or tap water to which a little vinegar has been added, is poured into the funnel. This exerts pressure on the underside of the molten wax, forcing it up through the straining cloth. The wax passing through the cloth overflows into the collecting channel or trough which surrounds the can, and then runs out of the spout into a bowl which has previously been smeared with soapy water to prevent the wax from sticking. Keep pouring water down the spout until the wax has all come through and water begins to flow out of the spout.

Pour off the surplus water to relieve the pressure under the cloth, and then remove the cloth. You can start again with a fresh load of wax. The straining cloth can be used over and over again, provided that you always put it on with the dirty side down.

Cold water can be poured down the funnel although it occasionally happens that the wax in the filler tube solidifies, blocking the tube. It is advisable to have a stick handy with which to clear the tube if necessary. Where continuous use of the appliance is intended, the use of hot water for pouring down the funnel is advised, as this reduces the time taken in reheating for the next melt.

TANGANYIKA METHOD OF RENDERING BEESWAX (1) (2)

This is a very efficient method of extracting the wax from all kinds of comb, including all brood combs, and it involves the use of only such utensils as are normally found in an African household. Further, the quality of the wax obtained is extremely good as it is not damaged by overheating or reaction with iron or zinc.

After separation from the honey, the wax is put into an earthenware cooking-pot with plenty of water and heated over the fire. When all the wax is melted, it and the water with it are poured into a long bag of woven rush, the top of the bag being held by an assistant or hung from a frame. With two sticks, one on each side, the bag is thoroughly squeezed to press out all the wax from the cocoons and other rubbish. Another pot under the straining bag catches the wax and water. The wax is then heated up again with fresh water and poured through a piece of coarse cotton cloth into a clean enamel bowl. The bowls are usually smeared with soapy water to prevent the wax from sticking. The vessels used hold just two kilos of beeswax (4·4 pounds). The bowls of clean wax are then covered over to keep out the dust and put in a safe place in a corner of a hut to cool slowly. When the wax is quite cold, the cake is shaken out of the bowl. Any dirt that has remained in the wax will have settled to

the bottom of the cake. This layer of dirty wax is scraped off and put in the pot for remelting and further straining.

This method of preparation, which is now general in all bee-keeping areas in Tanganyika, produces beeswax of high quality, clean and free from stains. The vessels used, earthenware cooking-pots, aluminium saucepans, tinned-steel petrol or kerosene tins and enamel bowls, have no ill-effects on the wax and are readily available in the villages. The rush straining bags are in common use for beer straining and coarse cotton cloth is obtainable in all the trading centres.

The stages in the cleaning process are as follows:

1. Melting the comb, from which the honey has been removed, in a pot containing plenty of water.
2. Straining the mixture through a rush beer strainer, the bag being thoroughly squeezed between two sticks.
3. Collecting the mixture of wax and water from the strainer and allowing it to cool slowly.
4. Remelting the wax in clean water, at least as much water as wax.
5. Straining the wax through a piece of cloth into a clean bowl, the bowl having been smeared with a film of soapy water; oil, fat or grease of any sort must not be used for this.
6. Putting the bowls of wax in a place away from draughts, covered to keep out dust and allowing it to cool slowly.
7. After the wax has become quite cold, shaking it out of the bowl and scraping any dirt that remains off the bottom of the cake.

Beeswax which has been so prepared requires no further treatment by trader or exporter.

The wax should never be boiled as this will cause a partial emulsification with the water. Plenty of water is always used to absorb the dirt in the wax, in particular the stains on the old dark brood combs.

Most of the wax which has been properly rendered will be a pale yellow colour, though some may be orange or russet due to the colour of the pollen which has been stored in the comb.

Cakes of wax of different colours should not be melted up together as the refiners like to be able to pick out different colours for different uses. The pale yellow waxes are used for making cosmetics and for pharmaceutical purposes, the orange and russet going into polishes, electrical insulation and other purposes where colour does not matter.

WAX PRESSES

The most efficient methods of rendering beeswax employ the use of some form of wax press, in which pressure is brought to bear, combined with heat, to remove the wax without leaving more than 1 to 3 per cent in the refuse.

There are three main forms of wax press in use, the German steam press, the Hershiser hot-water press and the Root wax press.

THE GERMAN STEAM PRESS

This is a steamer fitted with a screw plunger. Steam is generated in a compartment at the bottom of the appliance and rises through an opening in the false bottom and surrounds the comb, which is in a perforated metal basket beneath the plunger. The wax oozes through the basket, runs down on to a conical false bottom and passes out of the spout.

The appliance, with water in the bottom, is put on a stove so that the water heats up while the basket is being filled with combs wrapped in canvas bags. Between each bag is placed a circular board. The basket is then placed in the appliance and the screw turned up as far as it will go in the cross-arm. The cross-arm is locked in position by turning it until the bolts catch in the ears at the sides. As soon as steam is generated it will thoroughly heat the combs, and the molten wax runs out of the spout. When the wax stops running, pressure is applied by turning the screw, very slowly at first, and increasing the pressure by degrees. When the screw is down as far as it will go, it is turned back, the cross-bar taken out and the contents of the bags shaken up before being subjected to renewed steaming and pressure; this may have to be done two or three times to get out all the wax.

THE HERSHISER HOT-WATER PRESS

The Hershiser press consists of a square container, about eighteen inches each way. There is an opening in the bottom for a drain, and another for introducing water. The comb is wrapped in canvas and placed between slatted mats. The water is heated and pressure applied by means of the screw to press the melted wax out of the canvas bags. It is usual to relieve the pressure every ten minutes, to allow the comb to become thoroughly saturated again with hot water. Pressure should be applied slowly at first to avoid bursting the bags. Hot water is added from time to time, causing the melted wax to overflow through an outlet at the top.

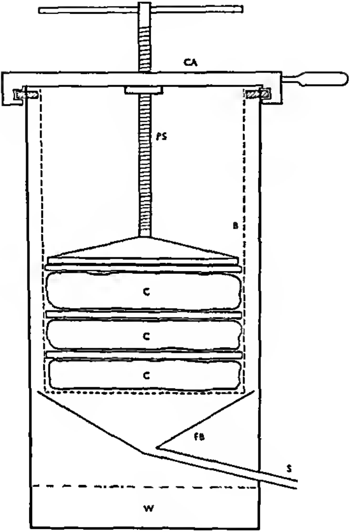


FIG. 40

GERMAN STEAM PRESS

CA, Cross arm; PS, Pressure screw; B, Basket; C, Comb; FB, Conical false bottom; S, Spout; W, Boiling water.

THE ROOT WAX PRESS (3)

This appliance consists of a round tin can with vertical wooden slats down the inside. Wooden slats go across the bottom and are covered with strong wire. A jet of steam is introduced from a boiler or kettle by means of a tinned copper pipe running down between the vertical slats on the side and towards the centre between two of

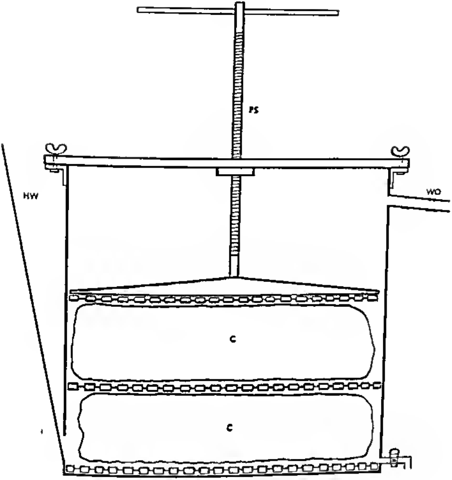


FIG. 41

HERSHISER HOT WATER PRESS

PS, Pressure screw; HW, Entrance for hot water; WO, Wax outlet; C, Comb.

the horizontal slats under the wire cloth. Pressure is applied by means of a screw, fitted with a spider, on to a cleated wooden board.

To use, a boiler is half-filled with water and put on a stove. The combs are put in gradually and stirred as they melt. When all the combs that the boiler will hold conveniently have been put in, allow the mass to melt completely, stirring frequently. Place a piece of canvas, about forty inches square, in the can and put in the board. Pour in hot water to heat the can and canvas and then pour this off and spread the canvas out in the can. Put about two gallons of melted comb into the press and fold the canvas neatly over it. Put

in the cleated board, slats down, and replace the can exactly under the spider. Screw down very slowly. Sufficient water should have been put in with the wax so that water and wax, when the spider is down, will just about submerge the spider. When the screw is down about as far as it will go, release the pressure until the spider is nearly out of the liquid and pull up the wooden board until it is free of the canvas, thus allowing the hot water to saturate the comb again. Then apply the pressure once more. This should be repeated two or three times. When the screw is down the last time, tip up the press, pouring all the water and wax into a mould, allowing the wax to cool very slowly, thus preventing the cake from cracking and permitting its removal in a solid piece.

If the work has been done carefully, the canvas and the refuse within will be quite dry and contain very little wax.

GENERAL POINTS

Points which should be remembered when rendering beeswax are as follows:

1. Iron, zinc, galvanized iron, brass and copper should not be used for the vessels or metal parts coming into contact with melted beeswax, because they tend to stain it. Aluminium, stainless steel, nickel, tinplate and enamelled ware are safe to use and do not stain the wax. Sometimes the moulds in which beeswax is allowed to set are made of wood.

2. Wax should be heated either in water or with a water jacket between it and the source of heat. Overheating causes decomposition of the wax and prolonged heating darkens its colour. Wax should not be heated more than is necessary to melt it. If water is boiled with wax the wax may form an emulsion with the water as well as being damaged by overheating. In addition, there is a danger of fire if the wax boils over.

3. Old brood combs and dark combs should be melted in water to improve the colour, and brood combs should be soaked in water before melting to saturate the cocoons and pollen.

4. Clean comb and dark comb should be rendered separately to prevent the wax of the clean comb from being stained by the dark comb. Beeswax of different colours should not be melted up together because the refiners use the different colours for different purposes.

5. The moulds may be smeared with soapy water to prevent the wax from sticking when it sets, but under no circumstances may any

oil or fat be used for tbis purpose. Once an oil, fat or other wax is mixed with beeswax it is impossible to remove it and sucb wax is adulterated.

BEESWAX LEGISLATION

Io the main manufacturing countries the specifications of genuine refined heeswax are laid down in the pharmacopoeias. In order that the quality of beeswax exported from Tanganyika should be of the standards required by the refiners in the manufacturing countries, rules were made defining the specifications of beeswax offered for export. These rules were made under the Produce Export Ordinance of Tanganyika, and are enforced by inspection by customs officers of consignments offered for export. The inspecting officers are trained in the examination of beeswax, and are able to recognize wax which is oot up to the standards required by the rules. Consignmeots containing adulterated, dirty, stained or overheated wax are oot permitted to be exported. Thus, there is no outlet for low-grade wax aod so the merchants refuse to buy anything but clean properly reodered heeswax. This iosistence on good quality is reflected right back to the producer who must prepare bis wax properly if he wants to sell it. Io this way is achieved the ideal required hy the refiners, oamely that the heeswax be properly rendered hy the producers in the first place so that it requires no further treatment uotil it reaches the refiners.

Tanganyika is, as far as is known, the only country with regulations coocerning the quality of beeswax offered for export, and these regulations are reproduced below.

G.N. 40 of 1/2/1957

THE PRODUCE EXPORT ORDINANCE
(CAP. 137)

RULES

(Made by the Governor in Council under section 10 of the Produce Export Ordinance)

THE PRODUCE EXPORT (BEESWAX) RULES, 1957

1. These rules may be cited as the Produce Export (Beeswax) Rules, 1957.

2. In these rules:

'beeswax' means the waxy product of the honeybee *Apis mellifera*, Linnaeus, otherwise known as *Apis mellifica*, Linnaeus, and the sub-species and varieties of *Apis mellifera* or *mellifica*, and so prepared that at the time of export:

(i) it contains no visible impurities;
(ii) it has a natural floral colour;
(iii) it has a pleasant floral scent;
(iv) it breaks with a granular, not crystalline, fracture;
(v) it is not sticky;
(vi) it has not been chemically bleached;
(vii) the specific gravity at 15·5 degrees/15·5 degrees C. lies between 0·955 and 0·970;
(viii) the melting point lies between 62·0 degrees C. and 65·0 degrees C.;
(ix) the setting point lies between 61·0 degrees C. and 62·5 degrees C.;
(x) it does not contain more than 1·0 per cent of volatile matter determined by heating for 6 hours at 100 degrees C. to 105 degrees C.;
(xi) on incineration it does not contain more than 0·2 per cent of ash;
(xii) it does not contain more than 1·0 per cent of matter insoluble in benzine;
(xiii) it does not contain more than 0·5 per cent of matter soluble in water;
(xiv) an aqueous solution is not acid to methyl orange;
(xv) the acid value lies between 17 and 21;
(xvi) the saponification value lies between 85 and 100;
(xvii) the ester value lies between 70 and 80;
(xviii) the iodine value lies between 5·0 and 12·0;
(xix) the refractive index at 75 degrees C. lies between 1·4396 and 1·4451;
(xx) the reaction to the Weinwurm Test is negative;
(xxi) the reaction to the Sterol Group Test is negative;
(xxii) the ratio number lies between 3·3 and 4·2;

but shall not include the product of any other species of *Apis*, other than *Apis mellifera* or *mellifica* and their sub-species and varieties, or the product of bees of other genera, or any mixture of these waxes with beeswax;

'chemically bleached beeswax' means beeswax that has been subjected to a chemical process in order to lighten its colour;

'sun bleached beeswax' means beeswax that has been subjected to the sun in order to lighten its colour and has not been subjected to any chemical bleaching process;

'the other East African territories' means the Colony and Protectorate of Kenya, and the Protectorate of Uganda;

'officer' means an officer employed in the service of the East Africa Customs and Excise Department.

3. No person shall export any article which purports to be beeswax or chemically bleached beeswax or sun bleached beeswax unless such article conforms to the appropriate definition contained in rule 2 of these Rules.

4. (1) All beeswax, chemically bleached beeswax or sun bleached beeswax exported from the Territory shall be packed in new 'B' twill gunny bags.

(2) (*a*) Every bag containing beeswax intended for export shall be plainly marked with the words 'Beeswax' and 'Produce of Tanganyika' in letters not less than two inches high;

(*b*) Every bag containing chemically bleached beeswax for export shall be plainly marked with the initials and words "CH. BL. Beeswax' and 'Produce of Tanganyika' in letters not less than two inches high;

(*c*) Every bag containing sun bleached beeswax intended for export shall be plainly marked with the initials and words 'SU. BL. Beeswax' and 'Produce of Tanganyika' in letters not less than two inches high;

(*d*) Every bag containing beeswax, chemically bleached beeswax or sun bleached beeswax intended for export shall be plainly marked in a manner sufficient to identify the exporter using letters not less than two inches high.

5. No beeswax, chemically bleached beeswax, or sun bleached beeswax shall be exported from the Territory except in broken pieces each not exceeding forty ounces in weight.

6. Except in the case of beeswax exported to the other East African Territories no beeswax, chemically bleached beeswax or sun bleached beeswax shall be exported from the Territory other than through the ports of Dar es Salaam, Lindi, Mtwara or Tanga.

7. No beeswax shall be exported from the Territory unless the export entry is endorsed by the exporter with a written warranty in the form set out in the schedule hereto.

8. The officer may open and examine the contents of such bags in each consignment as he may consider desirable and may at his discretion take samples, not exceeding five per cent of the weight of the bag and its contents, for analysis by the Government Chemist.

9. Any beeswax, chemically bleached beeswax or sun bleached beeswax which does not comply with rules 2 and 5 shall be detained by the officer and be liable to forfeiture. Any forfeited beeswax may be disposed of in such manner as the Chief Conservator of Forests may decide.

10. Beeswax that has been chemically bleached or sun bleached beeswax shall be clearly defined as such in contracts, export entries and bills of lading.

11. The Produce Export (Beeswax) Rules and the Produce Export (Beeswax) (Amendment) Rules, 1954, are hereby revoked.

SCHEDULE

Form of Warranty

I/We hereby certify that to the best of my/our knowledge and belief this consignment of beeswax/chemically bleached beeswax/sun bleached beeswax conforms to the specifications set out in the Produce Export (Beeswax) Rules, 1957.

Exporter

THE USES OF BEESWAX

The United States of America produces 2,000 tons of beeswax each year and imports a further 2,000 tons from tropical countries. Britain imports about 1,000 tons from the tropics, and the other countries of Western Europe together import at least as much as this, in addition to their domestic production. Glushkov (4) states that annual production of beeswax in the U.S.S.R. exceeds 2,500 tons and mentions the manufacture of 100 tons of comb foundation each year.

In Europe and America the heaviest consumer of beeswax in peace-time is the cosmetic industry. It is the basis of the emulsified ointments, creams and lotions, as well as lipsticks, eyebrow pencils, rouges, pomades, hair cream and theatrical grease paint and cream. Case Green (5), a leading beeswax refiner, estimates that 'at least 75 per cent of all the beeswax produced in the world finds its way into cosmetics and pharmaceutical preparations such as ointments and pill coatings.' That is undoubtedly the case with regard to the beeswax which comes on to the market in Europe and America and is imported into those areas from the tropics. But it is my estimation that only one-third, or at the most one-half, of the world's production of beeswax comes on to the market, the rest being thrown away by

honey hunters and beekeepers who are either ignorant of its value or too lazy to render it into marketable cakes. Great quantities are also lost in the honey used by primitive beer makers and in the cocoons and pollen through inefficient rendering of the combs.

Grout (6) considers that the second most important use is probably the production of church candles. This is of course one of the oldest uses of beeswax.

A major use is in the production of polishes, particularly floor polish, furniture polish and cream, shoe cream and polish, leather-dressing preparations and polishes, and car polish. However, the high price of beeswax caused by the demand of the cosmetic industry has forced some polish manufacturers to seek cheaper substitutes.

Grout (6) lists some two hundred different uses of beeswax, including ingredients of crayons, inks, carbon paper, sizing and waterproofing for paper, compositions for sizing and dressing of cloth, waterproofing canvas, paints and varnishes, electrical insulation, metallurgical purposes, anti-corrosion coatings for metal and waterproofing compounds, lubricants, moulding, pattern-making, sealing-wax and wax for treating skis, snow-shoes, archers' bow strings and sewing thread. Beeswax has also numerous military uses and is used in atomic research.

REFERENCES

1. HARRIS, W. V. (1940). *Beeswax.* Tanganyika Dep. Agric. Pamphl. No. 23.
2. SMITH, F. G. (1955). *Beeswax.* Tanganyika Beekeep. Div. Pamphl. No. 1.
3. ROOT, H. H. (1951). *Beeswax* (Brooklyn, New York: Chemical).
4. GLUSHKOV, N. M. (1958). 'Beekeeping in the U.S.S.R.' *Brit. Bee J.* 86(3915): 326–7.
5. GREEN, W. CASE (1958). 'The Value of Beeswax.' *Brit. Bee J.* 86(3897): 37–9.
6. GROUT, R. A. (1949). 'Production and uses of beeswax', pp. 519–34 of *The Hive and the Honey Bee* (Hamilton, Ill.: Dadant).

Chapter XXIV

NOTES ON DEVELOPING A BEEKEEPING INDUSTRY

Textbook—Demonstration Centre—Supply of Equipment—Supply of Bees—Beekeepers' Associations—Publicity—Development of Primitive Beekeeping.

This is a difficult subject to write on because what suits one country may not suit another at a different stage of cultural development. Also an important factor is the personality and drive of the few initiating the development, and the receptiveness and energy of the prospective bee farmers. The availability of an abundance of good bee forage will determine whether or not there is any scope for a bee-keeping industry. There needs to be a ready market for the honey and beeswax produced, and if this has not yet developed, marketing facilities will have to be organized.

TEXTBOOK

The first essential is a sound clear textbook on beekeeping which will guide the intending bee farmer who is starting up on his own. It is the author's earnest hope that this book will prove of some value in this respect.

DEMONSTRATION CENTRE

The next essential is an efficient economic bee farm which will form a demonstration centre. This may be established by private enterprise as was the case in the beginnings of commercial bee-keeping in the United States and more recently in Mexico, or it may be Government run. If the latter, it must be established on sound economic lines, efficiently equipped but without extravagance in buildings, equipment or staff.

So often one sees Government demonstration centres set up with a great deal of capital expenditure on buildings and the most modern and complicated equipment, which is not necessarily the best; a capital investment which would be ruinous to a commercial bee-keeper who has to make the business pay. There is a place for

Government expenditure on a more lavish scale than the commercial beekeeper can afford, and that is in research. For it is a reasonable function of a Government organization to conduct research programmes which would be beyond the means of the ordinary commercial beekeeper. But research establishments and demonstration centres should be kept distinctly separate and the bee farm run as an economic unit. However, it is perfectly allowable to test improved strains of bees or methods of management under field conditions on the demonstration bee farm, after they have been found to be satisfactory in the research apiaries.

There must be no extravagance in staff on the bee farm. One competent apiarist is all that is needed, though if he is also required to carry out extension work, an assistant may be required to perform the routine work and show visitors round while the apiarist is away visiting beekeepers or on a lecture tour.

Preferably, but not necessarily, the demonstration bee farm should be of a size which is an economic unit for one man, or one apiarist and an assistant to run, 200 or 300 productive colonies, in addition to the queen-rearing section. In Africa the apiaries should be in bee houses (they would be unmanageable otherwise), and bee houses may well be an advantage in Asia. The honey house, workshop and store should be adequate for the needs of the size of bee farm.

If provision is to be made for the running of courses of instruction, and this is most desirable, a lecture room, accommodation and messing facilities for the students may be required. These would not be a charge against the bee farm but on the instruction and extension services.

SUPPLY OF EQUIPMENT

If there is no established woodworking industry capable of working to the degree of accuracy required in the construction of beehives, it may be necessary for a government organization to arrange for the import and supply of beehives, and other equipment, until this can be taken over by private enterprise. Guidance should be given to local manufacturers of hives and equipment to ensure that the quality of materials used and the accuracy of construction are satisfactory. Nothing is more discouraging to a beekeeper than equipment which is not accurately made and results in the loss of the fine limits demanded of the 'bee space'. The importance of making standard and interchangeable equipment must be appreciated.

SUPPLY OF BEES

In a country where the beekeeping industry is established, the supply of queens and bees is carried out by commercial beekeepers. Where such a stage has not been reached, it may be necessary for a government organization to breed and supply queens of good quality. If the indigenous race of bees is not wholly satisfactory, no impediment should be placed in the way of those wishing to import good strains from other parts of the world. The chance of introducing a disease with queens from a reputable breeder is negligible, but it is desirable that the importer be a competent beekeeper who is familiar with the symptoms and treatment of bee diseases. In countries where the beekeepers are not yet sufficiently skilled, the importations should be carried out by a government organization, staffed and equipped for the introduction and testing of imported queens.

BEEKEEPERS' ASSOCIATIONS

Another way in which beekeeping development can be fostered is by the formation of beekeepers' associations for the exchange and spread of information on beekeeping. Usually such associations produce a journal, often monthly. Such a journal often starts in a small way, being only a few duplicated pages. When the tropics as a whole is considered, it is noteworthy that the greatest development in beekeeping is taking place where there are most associations. In South and Central America there are seven associations. In Africa there are two, one in the Union and one in Southern Rhodesia. In tropical Asia there is one, in India. Often beekeepers' associations arise on a local district level, and eventually amalgamate for the production of a better journal on a territory-wide basis as well as for bee insurance, standardization of equipment, marketing, library and other projects.

PUBLICITY

Newspaper articles and radio broadcasts are of great value and arouse interest in unexpected quarters. It is desirable that these be made a regular feature.

Exhibits at agricultural shows can also be of great value. Beekeeping equipment should be shown with specimens of high-grade honey and beeswax. Posters and photographs of commercial apiaries and honey houses are useful, but most valuable of all are moving exhibits. No beekeeping stand should be without an observation hive stocked with bees; that always draws a crowd. And if beekeeping

films can be shown oo a daylight screen, with a commeotary in tbe local language, theo the success of the stand is assured.

Experieoce with showing beekeeping films has revealed that they are a most valuable meaos of propaganda and iostruction, particularly wben they are locally made with local background and indigeoous characters. It has been found that tbe best approach to commentaries is to give a talk before the film starts on the subject of tbe film, aod then have a commeotary while tbe film is io progress. It is usually essential to have a public address system for giving a live commentary, or to use a souod projector and loudspeaker for a souod track commeotary in the local language. The recent iotroduction of magnetic stripe aod suitable equipmeot for its reproduction has made this much easier.

DEVELOPMENT OF PRIMITIVE BEEKEEPING

In backward areas wbere tbe inhabitants have not yet advaoced beyond honey-hunting, or the complete robbiog of simple hives, a different approach is required.

First, the area must be examined to determine which parts have the oatural resources for beekeepiog. Vegetation, rainfall, availability of water supplies and soil cooditions need to be coosidered. There must be facilities for tbe producers to dispose of tbeir beeswax and honey crops aod tbe market prices need to be sucb that tbe beekeepers will be encouraged to go to the trouble of cleaoiog their wax for sale and to take care in the handling of tbe honey they may wish to sell.

The responsibility for developing beekeeping in a backward area must be placed io the bands of a capable officer who bas beekeeping experience and who can give his wbole time to the subject. He should be assisted by Beekeeping Iostructors of good education, capable of reading and uoderstaoding the various textbooks aod journals on beekeeping, and wbo have an aptitude for beekeeping. The Beekeeping Iostructors can be assisted by Demoostrators. The Demonstrators should for prefereoce be sufficieotly educated to be able to read aod write in their own language, but it is esseotial that they be experieoced io bandling bees, eveo if only in the course of honey-hunting.

The traioiog of the Instructors should cover the subjects in this book, with particular emphasis io the early stages on simple hive beekeeping and beeswax aod honey preparation. The trainiog of the Demoostrators should cover the relationship between bees, plants aod man, simple bee biology, the making, baitiog and siting

published by the Bee Research Association, London. A comprehensive review of the most recent researches on the behaviour and social life of honeybees, to meet the needs of research workers and students as well as practical beekeepers.

The World of the Honeybee (1954), by C. G. Butler; published by Collins, London. A beautifully written and enthralling account of the natural history of honeybees.

American Honey Plants (1947), by F. G. Pellet; published by Orange Judd, New York. A wealth of information on bee forage in America, including many plants of importance in the tropics.

Flora Apicola de la America Tropical (1952), by G. S. Ordetx; published by Editorial Lex, La Habana, Cuba. For those who read Spanish, this is an extremely useful book.

Queen Rearing (1949), by L. E. Snelgrove; published by Snelgrove, Bleadon, Somerset. A useful review of the problems of bee breeding and most of the methods of queen rearing, with details of the methods used most successfully by the author.

Queen Rearing (1950), by H. H. Laidlaw and J. E. Eckert; published by Dadant and Sons, Hamilton, Illinois, U.S.A. Devoted to the fundamentals of queen rearing and bee breeding, and gives details of the Miller, Alley, Smith and Doolittle methods.

Honey in the Comb (1951), by C. E. Killion; published by Killion and Sons Apiaries, Paris, Illinois, U.S.A. The leading work on the production of comb honey, by a bee farmer who specializes in its production.

PERIODICALS

All beekeepers, as well as those responsible for the development of beekeeping, should join their local beekeepers' association and subscribe to the journal of the association. The association, and its journal, are most valuable means of exchanging knowledge about the craft. In addition to the useful information which can be obtained from the articles, the correspondence in such journals is often particularly fruitful.

In addition to the journals of the local associations, there are three journals in English which have a world-wide distribution and are a mine of information of value to beekeepers everywhere:

Bee World, which includes *Apicultural Abstracts*, published monthly by the Bee Research Association. It contains valuable articles and reviews of interest to all serious workers and students. Annual subscription, including membership of the Bee Research Association, £1 15*s*. ($6) to the Bee Research Association, Woodside House, Chalfont Heights, GERRARDS CROSS, Bucks., England.

The American Bee Journal, published monthly, \$2.50 a year, three years \$6.50, from the American Bee Journal, Hamilton, Illinois, U.S.A.

Gleanings in Bee Culture, published monthly, \$2.50 a year, three years \$6.50, from A. I. Root Co., Medina, Ohio, U.S.A.

The *American Bee Journal* has been published for ninety-eight years and *Gleanings in Bee Culture* for eighty-six years, and both are packed with information of great value and interest to all beekeepers, beginners as well as established commercial beekeepers.

Appendix II

BEEKEEPERS' ASSOCIATIONS IN THE TROPICS

AFRICA

Rhodesia: Rhodesian Beekeepers Association.
Secretary: H. T. Wadleigh, P.B. 167H, Salisbury, S. Rhodesia.
Journal: *Bee News*, from the secretary.

Union of South Africa: South African Association of Beekeepers.
Secretary: Mrs. E. M. Thompson, P.O. Box 3076, Johanneshurg.

ASIA

India: All India Beekeepers Association.
Secretary: R. N. Muttoo, Ramgarh, Dist. Nainital, U.P. India.
Journal: *The Indian Bee Journal*, monthly, Rs. 12/- or Shs. 17/6*d.* or $2.75 a year.

AMERICA

Argentina: Sociedad Argentina de Apicultores,
Maipu 220, Buenos Aires.

Bolivia: Co-operativa Apícola Boliviana,
Casilla 123, Santa Cruz de la Sierra.

Brazil: Federação dos Apicultores Brasileiros,
Rua de São Berto 100, Sobreloja, Sala H, São Paulo

Colombhia: Asociación Colombiana de Apicultores,
Apartado Aéreo 6709, Bogotá.

Costa Rica: Asociación Apícola de Costa Rica,
San José, Villa Puvenza, Apdo. 4005.

Cuba: Asociación Apícola de Cuba,
Patrocinio 159, Vibora, Havana.

Uruguay: Asociación Apícola Uruguaya,
Av. Uruguaya 864, Montevideo.

Appendix III

RELATIONSHIP BETWEEN SPECIFIC GRAVITY, REFRACTIVE INDEX AND MOISTURE CONTENT OF HONEY*

Moisture per cent	*Specific Gravity gms./cc. at 20° C.*	*Refractive Index at 20° C.*
13·0	1·4525	1·5041
·2	1·4510	1·5035
·4	1·4495	1·5030
·6	1·4481	1·5025
·8	1·4466	1·5020
14·0	1·4453	1·5015
·2	1·4438	1·5010
·4	1·4424	1·5005
·6	1·4409	1·5000
·8	1·4395	1·4995
15·0	1·4381	1·4990
·2	1·4367	1·4985
·4	1·4352	1·4980
·6	1·4338	1·4975
·8	1·4324	1·4970
16·0	1·4310	1·4965
·2	1·4295	1·4960
·4	1·4282	1·4955
·6	1·4267	1·4950
·8	1·4254	1·4945
17·0	1·4239	1·4940
·2	1·4225	1·4935
·4	1·4212	1·4930
·6	1·4197	1·4925
·8	1·4184	1·4920
18·0	1·4171	1·4915
·2	1·4156	1·4910
·4	1·4143	1·4905
·6	1·4129	1·4900
·8	1·4115	1·4895

* Adapted from Chataway, H. D. (1935), 'Honey tables, showing the relationship between various hydrometer scales and refractive index to moisture content and weight per gallon of honey.' *Canad. Bee J.* 43: 215.

HONEY TABLE

Moisture per cent	*Specific Gravity gms./cc. at 20° C.*	*Refractive Index at 20° C.*
19·0	1·4101	1·4890
·2	1·4087	1·4885
·4	1·4074	1·4880
·6	1·4060	1·4876
·8	1·4046	1·4871
20·0	1·4033	1·4866
·2	1·4020	1·4862
·4	1·4006	1·4858
·6	1·3992	1·4853
·8	1·3979	1·4849
21·0	1·3966	1·4844

Temperature corrections for the above table:

For each 1° C. rise in temperature over 20° C.
Specific gravity, subtract 0·0006 gms./cc.
Refractive index, subtract 0·00023.

For each 1° C. fall in temperature below 20° C. add the above corrections.

BIBLIOGRAPHY

ADAM, BROTHER (1954). 'Bee breeding.' *Bee World* 35: 4–13, 21–9, 44–9.

ADAM, BROTHER (1954). 'In search of the best strains of bee: second journey.' *Bee World* 35: 193–203, 233–44.

ALBER, M. A. (1956). 'Acarine disease in Uruguay.' *Bee World* 37: 72.

AMARAL, E. (1957). 'Honey bee activities and honey plants in Brazil.' *Amer. Bee J.* 97: 394–5.

ARAUJO, V. DE P. (1955). *Colmeias para 'obelhas sem ferrão' Meliponini.* Inst. de Angola Bull. No. 7.

ARAUJO, V. DE P. (1956). 'Notas bionomicas sobre *Apis mellifera adansonii* Latr.' *Dusenia* 7: 91–102.

BAILEY, L. (1954). 'The control of nosema disease.' *Bee World* 35: 111–13.

BAILEY, L. (1954). 'Science and practice: bee poisoning.' *Bee World* 35: 221–3.

BAILEY, L. (1955). 'Results of field trials at Rothamsted of control measures for nosema disease.' *Bee World* 36: 121–5.

BAILEY, L. (1955). 'Control of amoeba disease by the fumigation of combs and by fumagillin.' *Bee World* 36: 162–3.

BAILEY, L. (1957). 'The cause of European foul brood.' *Bee World* 38: 85–9.

BAILEY, L. and CARLISLE, E. (1956). 'Tests with acaricides on *Acaropis woodi* (Rennie)'. *Bee World* 37: 85–94.

BHATTI, S. H. S. (1951). 'Studies on migratory beekeeping in the Punjab.' *14th International beekeep. Congr.* Paper 21.

BURNSIDE, C. E. (1930). *Fungous diseases of the honeybees.* U.S. Dep. Agric. Tech. Bull. No. 149.

BUTLER, C. G. (1954). *The World of the Honeybee* (London: Collins).

BUTLER, C. G. (1954). 'The importance of "queen substance" in the life of the honeybee colony.' *Bee World* 35: 169–76.

BUTLER, C. G., JEFFREE, E. P., and KALMUS, H. (1943). 'The behaviour of a population of honeybees on an artificial and on a natural crop.' *Jour. exp. Biol.* 20: 65–73.

BUTLER, C. G. and SIMPSON, J. (1956). 'The introduction of virgin and mated queens directly and in a simple cage.' *Bee World* 37: 105–14.

CARR, A. F. (1953). 'Observations on beekeeping in British Guiana.' *Report of the State Apiarist, Iowa,* 1953: 73–4.

CHERIAN, M. C. and RAMACHANDRAN, S. (1942). 'Beekeeping in Madras.' *Indian Fmg.* 3: 552–3.

CHORLEY, T. W. (1936). 'Improvement in native bee-keeping in Uganda.' *E. Afr. Agric. J.* 1: 436–47.

COCKERALL, T. D. A. (1936). 'African honey bees.' *Nature* 8: 249.

COOPER, B. A. (1952). 'A review of two years' abstracts on spray poisoning (1950–51).' *Bee World* 33: 90–1.

COWAN, T. W. (1908). *Wax craft.* (London: British Bee J.)

CRANE, E. (1949). *Water and the honeybee colony.* Cent. Assoc. B.B.K.A. Lecture.

CRANE, E. (1954). 'Science and practice: American and European foul brood.' *Bee World* 35: 29–30.

CRANE, E. (1957). 'Second American bee journey: II, States of the south and west: III, Cuba and Mexico.' *Bee World* 38: 249–57, 301–13.

CULWICK, A. T. (1936). 'Ngindo honey-hunters.' *Man* 36: 73–4.

DADE, H. A. (1949). *The laboratory diagnosis of honey-bee diseases.* Quekett Microscopical Club Monograph No. 4.

DEANS, A. S. C. (1953). *The pollen analysis of honey.* Cent. Assoc. B.B.K.A. Lecture.

DEANS, A. S. C. (1957). *Survey of British honey sources.* Bee Research Assoc. Report BRA, 142.

DUBOIS, R. and COLLART, E. (1950). *L'apiculture au Congo Belge et au Ruanda-Urundi* (Bruxelles: Ministère des Colonies).

DYCE, E. J. (1931). *Fermentation and crystallization of honey.* Cornell Univ. Agric. Exp. Sta. Bull. No. 528.

DYCE, E. J. (1953). 'Beekeeping in Costa Rica.' *Amer. Bee J.* 93: 296–8.

DYCE, E. J. (1957). 'Beekeeping economics.' *Amer. Bee J.* 97: 88–9.

ECKERT, J. E. (1951). *Rehabilitation of the beekeeping industry in Hawaii.* Hawaii: Final Report I.R.A.C. Grant No. 19.

ECKERT, J. E. (1951). 'The development of resistance to A.F.B. in Hawaii.' *Amer. Bee J.* 91: 200–1.

ECKERT, J. E. and BESS, H. A. (1952). *Fundamentals of beekeeping in Hawaii.* Ext. Bull. Univ. Hawaii No. 55.

ELMENHORST, C. W. (1952). 'Beekeeping in Guatemala.' *Bee World* 33: 93–6.

FLORIDA DEPARTMENT OF AGRICULTURE (1951). *Beekeeping in Florida.* Spec. Ser. Fla. Dep. Agric. No. 66.

FREE, J. B. (1958). 'Attempts to condition bees to visit selected crops.' *Bee World* 39: 221–30.

FREE, J. B. and BUTLER, C. G. (1958). 'The size of apertures through which worker honeybees will feed one another.' *Bee World* 39: 40–2.

FRIEDMANN, H. (1955). *The honey-guides.* U.S. Nat. Mus. Bull. No. 208.

FRISCH, K. VON (1950). *Bees, their vision, chemical senses and language* (New York: Cornell Univ.).

FRISCH, K. VON (1952). 'Orienting ability and communication among bees.' *Bee World* 33: 19–25, 35–40.

FRISCH, K. VON (1955). 'Beobachtungen und Versuche M. Lindauers an indischen Bienen.' *S.B. bayer. Akad. Wiss.* (10): 209–16.

GIAVARINI, I. (1937). "Notizie sulle api e sull' apicoltura Abissina.' *V. Congr. Naz. Apic. Ital.*

GLUSHKOV, N. M. (1958). 'Bee-keeping in the U.S.S.R.' *British Bee J.* 86: 326–7.

GOONATILLAKE, A. P. (1928). 'Bee culture.' *Trop. Agricst.* 70.

GREEN, W. CASE (1958). 'The value of beeswax.' *British Bee J.* 86: 37–9.

GROUT, R. A. (1949). 'Production and uses of beeswax,' pp. 519–34 of *The Hive and the Honey Bee* (Hamilton, Ill.: Dadant).

HAMILTON, W. (1945). *The Art of Beekeeping* (York: Herald).

(HARRIS, W. V.) (1929). 'A new beehive.' *Bee World* 10: 57–8.

HARRIS, W. V. (1931). 'A short note on the races of honey bees in Tanganyika Territory.' *Bee World* 12: 90–1.

HARRIS, W. V. (1932). 'Native beekeeping in Tanganyika.' *Trop. Agric. Trin.* 9: 231–5.

HARRIS, W. V. (1940). *Beeswax.* Tanganyika Dep. Agric. Pamphl. No. 23.

HEWITT, J. (1892). 'Fertile workers—their utility.' *J. Hort. Lond.* 25: 134.

IMPERIAL INSTITUTE (1922). 'Indian beeswax.' *Bull. Imp. Inst.* 20: 155–62.

IMPERIAL INSTITUTE (1935). 'African beeswax.' *Bull. Imp. Inst.* 33: 295–303.

JACK, R. W. (1916). 'Parthenogenesis among the workers of the Cape honeybee: Mr. G. W. Onions' experiments.' *Trans. Roy. Ent. Soc. Lond.* 21: 396–403.

JASIM, K. (1952). 'Beekeeping in Iraq.' *Mod. Beekeep.* 36: 405–7, 414.

JEFFREE, E. P. (1955). 'Acarine disease of the honeybee and temperature.' *Nature* 175: 91.

JEFFREE, E. P. (1957). *Some aspects of the seasonal course of honeybee colonies and the changing background of flowering plants on which they forage.* Univ. Aberdeen D.Sc. Thesis.

KAPIL, R. P. (1957). 'The length of life and the brood-rearing cycle of the Indian bee.' *Bee World* 38: 258–63.

KELLOG, C. R. (1950). Beekeeping notes from Mexico. *Report of the State Apiorist, Iowa,* 1950: 19–23.

KEMPFF MERCADO, N. (1952). 'Enemigos del apiario: algunas abejas indigenas.' *Campo, La Paz* 5: 5–7.

KERR, W. E. (1957). 'Introduction of African bees to Brazil.' *Brasil apic.* 3: 211–13.

KIAT, L. C. (1954). 'Beekeeping in Singapore.' *Glean. Bee Cult.* 82: 649–50, 657.

LAIDLAW, H. H. and ECKERT, J. E. (1950). *Queen rearing* (Hamilton, Ill.: Dadant).

LAMB, P. H. (1929). 'Beekeeping in Tanganyika Territory.' *Bee World* 10: 121.

LE MAISTRE, W. G. (1949). 'Cost of producing honey.' *Canad. Bee J.* 57(6): 16–18.

LE MAISTRE, W. G. (1952). 'Beekeeping profits.' *Canad. Bee J.* 60(6): 12–15.

LINDAUER, M. (1955). 'The water economy and temperature regulation of the honeybee colony.' *Bee World* 36: 62–72, 81–92, 105–11.

LINDAUER, M. (1957). 'Communication among the honeybees and stingless bees of India.' *Bee World* 38: 3–14, 34–9.

LUMLEY, E. K. (1928). 'Beekeeping in Tanganyika Territory.' *Bee World* 9: 120–2.

LUNDIE, A. E. (1940). *The small hive beetle, 'Aethina tumida.'* Sci. Bull. S. Afr. Dep. Agric. No. 220.

LUNDIE, A. E. (1951–2). 'The principal diseases and enemies of honey bees.' *S. Afr. Bee J.* 26(4): 15–16; (5): 13, 15; (6): 13, 14; 27(1): 9; (2): 13, 15; (3): 15–17.

MACMILLAN, H. F. (1949). *Tropical Planting and Gardening* (London: Macmillan).

MACKENSEN, O. (1943). 'The occurrence of parthenogenetic females in some strains of honeybees.' *J. Econ. Ent.* 36: 465–7.

MADRAS, GOVERNMENT ENTOMOLOGIST (1951). 'A short review of work on beekeeping in Madras.' *Indian Bee J.* 13: 61–5, 68–70.

MANLEY, R. O. B. (1945). *Honey Farming* (London: Faber).

MANLEY, R. O. B. (1946). *Honey Production in the British Isles* (London: Faber).

MANLEY, R.O.B. (1948). *Beekeeping in Britain* (London: Faber).

MATHIS, G. (1930). 'Italian bees for South Africa.' *Bee World* 11: 124.

MEDICI, M. (1951). 'L'apicoltura nella Repubblica Argentina.' *Ape* 35(6): 97–8.

MICHAEL, A. S. (1954). *American foulbrood of honey bees—how to control it.* U.S. Dep. Agric. Farmers' Bull. No. 2074.

MILNE, P. S. (1957). 'Acarine disease in *Apis indica*.' *Bee World* 38: 156.

MINISTRY OF AGRICULTURE AND FISHERIES (1931). *Report on the marketing of honey and beeswax in England and Wales.* Econ. Ser. No. 28 (London: H.M. Stationery Office).

MINISTRY OF AGRICULTURE AND FISHERIES (1949). *Diseases of bees.* Min. Agric. Bull. No. 100.

MINISTRY OF AGRICULTURE AND FISHERIES (1952). *The examination of bees for acarine disease.* Min. Agric. Advisory Lft. No. 362.

MINISTRY OF AGRICULTURE AND FISHERIES (1953). *Foul brood.* Min. Agric. Advisory Lft. No. 306.

MINISTRY OF AGRICULTURE AND FISHERIES (1954). *Acarine disease of bees.* Min. Agric. Advisory Lft. No. 330.

MUNRO, J. A. (1953). 'Beekeeping in Bolivia.' *Glean. Bee Cult.* 81: 204–8, 253.

MUNRO, J. A. (1954). 'Sidelights of beekeeping in Brazil.' *Amer. Bee J.* 94: 380–2.

MUTTOO, R. N. (1944). 'Bee-keeping in India: its past, present and future.' *Indian Bee J.* 6: 54–77.

MUTTOO, R. N. (1949). *Honey bees.* Bhupen Apiaries Pict. Ser. No. 1.

MUTTOO, R. N. (1949). *Enemies of honey bees in India.* Bhupen Apiaries Pict. Ser. No. 2.

MUTTOO, R. N. (1956). 'Facts about beekeeping in India.' *Bee World* 37: 125–33.

MUTTOO, R. N. (1957). 'Some So-called "Peculiarities" of Behaviour of Indian Honeybees as Compared to the European bees.' *Indian Bee J.* 19: 62–4.

NESTERVODSKI, V. A. (1952). ['Work of bees in shaded and unshaded hives.'] *Pchelovodstvo* 29(7): 28–30.

NOGUEIRO-NETO, P. (1953). *A criacão de abelhos indigenos sem ferrão.* São Paulo: Editora Chacaras e Quintais.

ONIONS, G. W. (1912). 'South African "fertile" worker bees.' *Agric. J. Un. S. Afr.* 3: 720–8.

ORDETX, G. S. (1944). 'Plantas meliferas de Cuba.' *Rev. Agric. La Habano* 27(24): 5–160.

ORDETX, G. S. (1952). *Flora apicola de la America tropical.* La Habana, Cuba: Editorial Lex.

ORDETX, G. S. (1956). 'Beekeeping in Cuba.' *Amer. Bee J.* 96: 27–8.

ORDETX, G. S. (1957). 'Beekeeping in Cuba.' *Glean. Bee Cult.* 85: 168–71.

OTANES, F. Q. (1950). *Beekeeping in the Philippines* Philippines Republic Dep. Agric.

PELLETT, F. C. (1947). *American honey plants* (New York: Orange Judd).

PETTIGREW, A. (1889). *The Handy Book of Bees* (Edinburgh).

PHILLIPS, E. F. (1914). *Porto Rican beekeeping.* Bull. Porto Rico Agric. Exp. Sta. No. 15.

RAHMAN, K. A. and SINGH, S. (1940). 'Beekeeping in India.' *Indian Forming* 1(1): 10–17.

RAHMAN, K. A. and SINGH, S. (1941). 'Nectar and pollen plants of the Punjab.' *Indian Bee J.* 4: 32–5.

RAW, G. R. (1954). 'Science and practice: enemies of bees.' *Bee World* 35: 159–60.

RAYMENT, T. (1923). 'Through Australian eyes—water in cells.' *Amer. Bee J.* 63: 135–6

RIBBANDS, C. R. (1952). 'The relation between the foraging range of honeybees and their honey production.' *Bee World* 33: 2–6.

RIBBANDS, C. R. (1953). *The behaviour and social life of honeybees* (London: Bee Research Assoc.).

ROOT, A. I. *et. al.* (1948). *The ABC and XYZ of Bee Culture* (Medina, Ohio: Root).

ROOT, H. H. (1951). *Beeswax* (Brooklyn, New York: Chemical).

ROTTER, E. (1931). 'African races of honey bees.' *Bee World* 12: 67–8.

SCHWARTZ, H. F. (1948). *Stingless bees (Meliponidae) of the Western Hemisphere.* Bull. Amer. Mus. Nat. Hist. No. 90.

SEN, J. and BANERJEE, D. (1956). 'A pollen analysis of Indian honey.' *Bee World* 37: 52–4.

SINGH, S. (1957). *Final report of the beekeeping research scheme, Punjab, 1945–54* (Chandigarh: Controller of Printing and Stationery).

SINGH, S. (1957). 'Acarine disease in the Indian honey bee.' *Indian Bee J.* 19: 27–8.

SINGH, S. and ADLAKHA, R. L. (1958). 'Acarine disease of adult honeybees.' *Indian Bee J.* 20: 64–78.

SKAIFE, S. H. (1921). 'On *Broula coeca* Nietzsch, a dipterous parasite of the honeybee.' *Trans. Roy. Soc. S. Afr.* 10: 41–8.

SKAIFE, S. H. (1930). 'Insect pests of the hive. I. The Tachnid parasite.' *Bee World* 11: 106–7.

SKAIFE, S. H. (1930). 'The South African honey-bee.' *S. Afr. Bee J.* 5(2): 12–16.

SMITH, F. G. (1953). 'Beekeeping in the tropics.' *Bee World* 34: 233–45.

SMITH, F. G. (1954). 'Notes on the biology and waxes of four species of African *Trigona* bees.' *Proc. Roy. Ent. Soc. Lond. Ser. A* 29: 62–70.

SMITH, F. G. (1955). *Beeswax.* Tanganyika Beekeep. Div. Pamphl. No. 1.

SMITH, F. G. (1956). *Honey.* Tanganyika Beekeep. Div. Pamphl. No. 3.

SMITH, F. G. (1956). *Bee botany in Tanganyika.* Aberdeen Univ. D.Sc. Thesis.

SMITH, F. O. (1957). 'Bee botany in East Africa.' *E. Afr. Agric. J.* 23: 119–26.

SMITH, F. G. (1958). 'Beekeeping observations in Tanganyika, 1949–57.' *Bee World* 39: 29–36.

SMITH, F. G. (1958). 'Foul brood in tropical Africa.' *Bee World* 39: 230–2.

SMITH, F. G. (1958). 'Communication and foraging range of the African honeybees compared with that of the European and Asian bees.' *Bee World* 39: 249–52.

SNELGROVE, L. E. (1949). *Queen Rearing* (Bleadon, Somerset: Snelgrove).

SNODGRASS, R. E. (1949). 'The anatomy of the honey bee,' pp. 473–518 of *The Hive and the Honey Bee* (Hamilton, Ill.: Dadant).

STANLEY, P. W. *The Stanley System of Queen Rearing* (Hambrook Grange, Chichester).

SUBRAMANIAM, T. V. (1938). *Beekeeping for beginners.* Mysore Dep. Agric. Ent. Ser. Bull. No. 10.

TAYLOR, F. (1934). 'Diseases and enemies of bees.' *Fmg. in S. Afr.* 71–8.

TAYLOR, F. (1939). *Beekeeping for the beginner.* Un. of S. Afr. Dep. Agric. and For. Bull. No. 199.

TOUMANOFF, C. (1939). *Les ennemis des abeilles* (Hanoi: Imprimerie d'Extrême-Orient).

TOWER, W. V. (1913). *Beekeeping in Porto Rico.* Circ. Porto Rico agric. Exp. Sta. No. 13.

UNITED STATES DEPARTMENT OF AGRICULTURE (1942). *The dependence of agriculture on the beekeeping industry.* U.S. Dep. Agric. Circ. No. E-584.

WARTH, A. H. (1947). *The Chemistry and Technology of Waxes* (New York: Reinhold).

WEDMORE, E. B. (1946). *A Manual of Beekeeping* (London: Arnold).

WEDMORE, E. B. (1947). *The Ventilation of Bee Hives* (Petts Wood: Bee Craft).

WEGNER, A. M. R. (1949). 'A remarkable observation on the Indian honeybee versus the yellow-throated marten from Java.' *Treubia* 20(1): 31–3.

WHITCOMBE, H. J. (1956). *Bees are My Business* (London: Gollancz).

WIESE, I. H. (1957). 'The toxicity of modern insecticides to the South African honey-bee.' *S. Afr. Bee J.* 32(2): 7, 9–10; (3): 6–7, 9–10; (4): 5, 7; (5): 9–11; (6): 10–11.

WILLSON, R. B. (1953). 'Beekeeping in Mexico.' *Glean. Bee Cult.* 81: 79–82, 145–6.

WILLSON, R. B. (1955). 'Meet the champions: Miel Carlota.' *Glean. Bee Cult.* 83: 329–32, 408–10, 447, 473–6, 509.

INDEX

S